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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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Education and the Nation.

On Sunday, November 27, Mr. Fisher, President of the Board of Education, speaking in Whitefield's Mission, London, on "Our Schools," said:

"Education is a great unifying influence, not only between classes, but also between nations. The estranging influences between man and man are not rooted in the externals of situation or wealth, but are founded in differences of intellectual acquisition and of intellectual and moral outlook. There still persists the delusion that the education of the poor must be different, not only in amount, but also in quality, from the education which is at the service of the more affluent members of the nation. But the poor, even more than the rich, stand in need of the best possible education, since they lack the home advantages of the wealthy. Indeed, in the crowded areas of the cities the school plays an even greater part than the home in the formation of the national mind. The elementary school may not give all the results we are entitled to expect, though there has been great progress made in the last generation through the development of a spirit of humanism in the schools. It will not become fruitful in result until something is done to provide education for the vital period of adolescence."

This was the spirit that animated Mr. Fisher in the drafting of the measure which culminated in the Education Act of 1918, and served to mark the public appreciation of the benefits of education and the great progress made since the Education Act of 1902. Mr. Fisher stated that day continuation schools were provided for in the Education Act of 1918, but, owing to financial circumstances, at the present time they could not develop the system adequately. He added that the children of the nation needed more schools, more books, and better teachers, and if the nation was in earnest they would assuredly get them in time. Yet the Board of Education has continually thwarted the progressive efforts of the more enterprising local authorities in the provision of new schools; it hampers the provision of Central Schools in London even where such provision can be made by the reorganisation of existing elementary schools, and it checks the development of schools where physically defective children can receive remedial treatment.

There has arisen—and it is an extremely hopeful sign of the public interest in the value of education—a strong demand for the advantages of higher education, and thousands of children in all parts of the country are eager for admission to secondary schools; but the Board offers no encouragement to that end; in fact, it has sanctioned the raising of the fees in such schools, thereby preventing the poorer children from taking advantage of them, and

the same policy is being pursued with respect to the much-needed nursery schools for children under five. Day continuation classes during two years, as provided for by the Act, for young people who have left the elementary school at fourteen in order to enter into employment, are, except in the London area, practically a dead letter, the Board refusing its sanction to the fixing of the appointed day.

The Committee of business men appointed by the Chancellor of the Exchequer, with Sir Eric Geddes as chairman, to consider the national expenditure with a view to drastic economies in the various spending departments has presented its Report to the Cabinet, but its full details have not been made public. It is rumoured that there is a proposed reduction in the total estimates for the year 1922–23 of 195,000,000*l.*, of which the education estimates are responsible for 16,000,000*l.* As showing the spirit in which this question has been approached, Lord Inchcape, one of the influential members of this Committee, and the chairman of the P. and O., said, at a recent meeting of the shareholders of his company, that "education is an excellent thing in its way, but there are limitations to its economic usefulness." Lord Haldane, at a meeting held at London University on December 17, arranged by the London Head Teachers' Association, dealt effectively with Lord Inchcape's observations, and showed how much the progress of the nation in every department of industrial life and even in his own particular business of shipping has been due to education. He said:

"Lord Inchcape could not sail a single steamer but for the education of the great inventors and men of science which made it possible, nor would his staff know how to handle the instruments but for the training they have received from their teachers. Modern business cannot stand still, neither can education. Other nations realise the value of education, and will get ahead of us if we do not; if we neglect it, hard times will come, when we shall be driven belatedly to reverse the policy threatened to-day in order to recover our resources and progress, which will have failed us through our misunderstanding of the true meaning of economy."

In this respect the decision of the Treasury to reduce the grant to the universities from 1,500,000*l.* to 1,200,000*l.* will seriously hamper these institutions in their endeavour to get and to retain competent teachers, and will impede scientific research on which a further advance in knowledge and especially industry, alike in the spheres of manufactures and of agriculture, so largely depends. The joint meeting of the general council of the Trade Union Congress and the Labour Party Executive, held in London on December 14, views this policy with profound disapproval, which can do virtually nothing, it says, "to relieve the national finances, but which will be a serious blow to higher education."

An important manifesto has recently been issued by the Teachers' Registration Council, entitled "Education and National Life," for presentation to his Majesty's Ministers and in the expectation that it will be signed by many eminent men and women. It refers to the national danger which attends any attempt to reduce expenditure on education, and urges that the recent extension of the franchise has made it the more necessary to open all possible avenues of knowledge and enlightenment as preventives of error and half-truths in politics, economics, and social relationships. A complete and generous system of education will fortify the State against civil unrest and strife, while serving to widen the vision and enrich the lives of individuals. We were led in the tragic ordeal of the war to perceive the faults of our previous educational system and to frame the new proposals embodied in the Education Act of 1918. But that measure is not really in operation, and the newly awakened desire of working people for further knowledge is left unsatisfied. The signatories recognise the need for a careful survey of our national resources and for thrift in all public and private expenditure, but hold that thrift should be exercised with discrimination and not so as to curtail educational opportunity. They conclude with the desire to see our country take its place in the van of civilised and enlightened communities and regard public expenditure on education as a wise investment which will bring to this and succeeding generations the rich rewards of civic greatness and private contentment.

It is to be hoped that this weighty manifesto from an influential body of well-wishers to education may receive speedy and favourable consideration at the hands of the Government, in order that the provisions of the Education Act of 1918 may be put into practical operation without further delay, and also that the full grant of 1,500,000*l.* be restored to the universities so as to encourage research in all departments of knowledge and give them the opportunity of fully developing their resources in the vital and permanent best interests of the nation.

Fifty Years of Electrical Science.

Fifty Years of Electricity: The Memories of an Electrical Engineer. By Prof. J. A. Fleming. Pp. xi + 371. (London: The Wireless Press, Ltd., n.d.) 30*s*. net.

IN giving us his memories of the past fifty years, Prof. Fleming has compiled a noteworthy work. "The book makes no claim," he writes, "to be a systematic treatise on electricity or electrical engineering, but is simply intended as an attempt to place before the intelligent general reader a fairly comprehensive view of the chief triumphs of applied electricity during the last half-century." The intention is carried out with the clearness of style and the lucidity of expression we have long learned to expect from the author. He may be assured that, as he hopes, it will "assist junior engineering students in obtaining a preliminary acquaintance with the outlines of a subject they will study in greater detail in other books," while to those who are not going to be professional physicists or engineers it will give a far more useful appreciation of what electricity is and what it has done than they gain from their attempts to verify Ohm's law or measure the magnetic moment of a piece of magnetised steel. Electrical progress lends itself in a very special way to treatment of this kind, but if it were possible to do for other branches of science what Fleming has achieved for his the gain would be very great.

From Sturgeon, who in 1825 constructed the first electro-magnet, to Einstein, whose work is referred to in one of the later chapters of the book, is nearly twice fifty years, but the work of the first half of the period, though fundamental, is passed over briefly in an introductory chapter. We are reminded of the importance of Sturgeon's discovery, of its extension by Joule and Faraday and Henry, and its almost immediate application to the electric telegraph by Cooke, Wheatstone, and Morse, culminating in the Hughes printing telegraph, for which the first U.S. patent was secured in 1855; the laying of the first Atlantic cable, 1857–58, which survived for only two months; the work of William Thomson, Lord Kelvin, based on his Royal Society paper of 1855 on "The Theory of the Electric Telegraph," leading to the mirror galvanometer (1858) and the siphon recorder (1867) after the successful laying of the 1866 cable.

Electrical telegraphy in England was at first developed entirely by private enterprise, and in 1870, when the business was taken over by the State, the various companies owned altogether some 16,000 miles of lines. Up to this time, the date at which Prof. Fleming's memories start and his detailed history begins, electrical engineering had been almost entirely concerned with telegraph work. The Society of Telegraph Engineers and Electricians—afterwards to become the Institution of Electrical Engineers—was in 1870 the only electro-technical society in England.

But the seeds of a greater development had been planted. Electro-magnetic induction was discovered by Faraday in 1831. From that followed the early magneto machines of Saxton (1833) and Clarke (1835); the Siemens armature was devised in 1856, the Gramme ring by Pacinotti in 1860. Wilde, in 1850, had used electromagnets instead of permanent magnets for the field-coils of a machine, and this was followed, in 1867, by the invention of the dynamo; the machine became self-exciting.

The account of these fifty years occupies some fifty pages of Prof. Fleming's book; for the next fifty the remaining 300 pages barely suffice. In six chapters details are given of the advance in all directions. Telegraphs and telephones, from Hughes's first printing instrument and Graham Bell's early telephone to the modern multiplex type machines and the automatic telephone exchange, are all described. Then we have dynamos, alternators, transformers, and motors, from 1870 to 1920, from the first Gramme and Siemens machines of some few kilowatts to the giants of the present day. Another chapter treats of electric lamps and lighting; yet another of supply stations, storage batteries, and railways; while fifty pages are devoted to electric theory and measurements, from Kelvin and the work of the first British Association Committee on Electrical Units in 1861–62 to Maxwell and theories of the ether, the discoveries of J. J. Thomson and Rutherford, and the influence of Einstein on modern physics. The final chapter deals with wireless telegraphy. Commencing with the theoretical work of Maxwell and Hertz, it passes in review the experiments of Hertz, Lodge, and Admiral Jackson, concluding with those of Marconi and his associates. An account is given of the valve detector devised by the author in 1904, and of the improvement due to Dr. Lee de Forest, by which it became the triode valve and amplifier for wireless waves.

This very brief *résumé* will indicate the scope and extent of the work. The limitations of space prevent any detailed account, and indeed no such account is necessary beyond the statement that all important developments in electrotechnics of the last fifty years are described with the well-

known skill of the author, who has added to our libraries a most useful and interesting work. Both he and the Wireless Press, which has produced the book, may be cordially congratulated on the result of their labours.

Fermat's Last Theorem.

Three Lectures on Fermat's Last Theorem. By L. J. Mordell. Pp. vii + 31. (Cambridge: At the University Press, 1921.) 4*s.* net.

THE "last theorem of Fermat" states that if x, y, z, p denote positive integers, the equation $x^p + y^p = z^p$ is impossible if p exceeds 2: thus no cube can be the sum of two cubes, and so on. If the theorem is true when p is 4, or an odd prime, it is true for all other integral values of p. For three centuries this theorem has baffled the efforts of all who have attacked it, although it has attracted the attention of all first-rate arithmeticians, and a great number of amateurs. For $p = 3, 4, 5, 7$ comparatively simple proofs have been discovered; but so far none of these has led to a complete generalisation.

The first great advance in the theory was made by Kummer, in connection with his researches on cyclotomic integers. He showed that if the theorem is false for any particular odd prime p, then p must not be a factor of the numerator of any one of the first $\frac{1}{2}(p-3)$ numbers of Bernoulli. This very recondite test rules out all values of p below 100 except 37, 59, 67. By additional criteria Kummer was able to prove the theorem for these exceptional primes, and hence for all values of p from 3 to 100 inclusive.

Not many years ago (1907) a prize of 100,000 marks was set aside for the first who succeeded in giving a complete proof or disproof of the theorem. Quite recently, new criteria, independent of Kummer's, have been discovered, which have to be satisfied by odd primes p for which the theorem is false, and the simplest of these is the condition $2^{p-1} \equiv 1 \pmod{p^2}$, discovered by Wilferich in 1909. Other tests of a more or less similar kind have been accumulated, and the net result is that any value of p for which the theorem is false must exceed 7000. Gauss's tables of quadratic forms warn us not to draw any conclusions from this result; in fact if N is any *assigned* integer, however large, a proof that the theorem is true unless $p > N$ gives us no information about the truth or falsity of the theorem in general.

Mr. Mordell's lectures give a clear and interesting account of the history and present state of this subject. Lecture I. gives a statement of the theorem, and a summary of the work done by Kummer's predecessors; Lecture II. is on Kummer's researches, and more recent investigations of similar type; and Lecture III. gives an account of various results obtained by Libri, Sophie Germain, and others. Full references are given to the original papers, so that a reader within reach of a good reference library can make himself acquainted with details of all that has been done hitherto.

A perplexing circumstance, often alluded to, is the fact that, in a private note, Fermat distinctly asserted that he had proved the theorem. Now Fermat was never convicted of a false assertion, and only once of a wrong conjecture; on the other hand it is extremely improbable that Fermat's proof, if he had one, was in any way analogous to the work of Kummer and his successors. It is not, perhaps, unreasonable to hope that a proof may be found, some day, derived from Diophantine analysis proper, combined with a process of induction, and possibly with some application of analytical geometry, or theory of equations, or both. A really gifted youth, approaching the problem without knowledge of modern analysis, might throw a quite new and unexpected light upon it.

Mr. Mordell's pamphlet ought to do much to stimulate our rising mathematicians, and we hope that it will have a large circulation.

G. B. M.

Chemistry of Coke-oven and By-product Works.

Coke-oven and By-product Works Chemistry. By T. Biddulph-Smith. Pp. x + 180 + 7 plates. (London: Charles Griffin and Co., Ltd., 1921.) 21*s.*

THE author states in the preface that his object in compiling this book is to furnish a concise manual covering, so far as space will allow, the general work required for the chemical control of coke-oven and by-product works. As regards the variety of subjects treated, he has doubtless achieved his object, but it is to be regretted that the apparent exigencies of space have caused the manual to become so concise in certain sections as to detract appreciably from the value of the work as a whole.

The most valuable section of the manual is that relating to the coal-tar naphthas. There is no doubt that the author has taken considerable pains to collect together the work of some of our best analytical chemists on methods of evaluating the constituents of coal-tar naphthas—work which

was carried out during the war period when the adequate examination of these products was a matter of such great importance. Although most of the methods dealt with have already been described either in technical journals or in the proceedings of technical societies, chemists will welcome the accumulation of this information within the covers of one volume. Moreover, the admirable summary of "The Constituents of Coal-tar and their Properties," compiled by Dr. Spielman, appears in a revised form as an appendix, and the inclusion of this information may prove useful to the coke-oven chemist by saving reference work.

The rest of the book is disappointing. In describing analytical methods the author has obviously attempted to do more than supply indications of the method recommended by him, but has failed to furnish sufficient detailed information to be of real service to the works chemist.

The chapter dealing with the fractions of coal-tar other than the naphtha fraction is meagre, and the weakness of this section accentuates the fact that chemists have not yet given adequate study to the analytical methods required in the examination of the heavier fractions of coal-tar, which are no less important than the naphtha distillate. It is in this section of the book that a recommendation appears which would have shocked those older and well-established chemists who attempted to teach us our subject, and who, not living in these times of efficiency systems and labour-saving devices, paid due reverence to instruments by which accurate measurements might be made. The recommendation refers to the crystallisation of crude tar acids, the instructions being to cool the liquid, "stirring continually with a Fahrenheit thermometer graduated in tenths of a degree."

The treatment accorded in other sections of the book to the analysis of gases, calorimetry, and the examination of chemical products made and required in the recovery works is all too brief. The analysis of coal-gas, which is acknowledged to be so intricate as to require considerable experience before trustworthy results can be expected, is dealt with in a few pages, whilst the method of procedure recommended is archaic. The estimation of naphthalene is carried out by a method which would be quite unpractical if small quantities of ammonia were present in the gas, though no mention is made of this fact.

Finally, the manual contains the usual collection of tables and conversion factors in the second appendix—so useful to reader, author, and publisher.

E. V. EVANS.

Lichens.

(1) *Lichens.* By A. L. Smith. (Cambridge Botanical Handbooks.) Pp. xxviii + 464. (Cambridge: At the University Press, 1921.) 55s. net.

(2) *A Handbook of the British Lichens.* By Annie Lorrain Smith. Pp. vii + 158. (London: The British Museum (Natural History), 1921.) 6s. 6d.

(1) FOR many years botanists have been without a guide to the large mass of facts that have been added year by year to our knowledge of lichens. Miss A. Lorrain Smith has therefore done a good work in compiling a very comprehensive handbook on this group of plants. The growth of our manufacturing and even our garden cities proves fatal to all except a few insignificant lichens. They are driven away to those far-off parts of the country where the air is still fresh and pure. This circumstance very possibly, but the absence of any comprehensive handbook on, and guide to, the lichens certainly, is a reason why so little interest is taken in this group. Yet, ecologically, it is one of the most interesting groups. Lichens grow on the outskirts of vegetation, as pioneers of the plant world, preparing the way for moss, fern and flowering plant. They are most intimately in touch with the substratum in its virgin condition. Few ecologists, however, properly consider lichens. Anatomically, the lichen thallus very directly reflects the nature of the substratum. A great deal, however, still remains to be done in this direction. The elaborate and careful work of the late Abbé Hue has, unfortunately, not brought much morphological order into our knowledge of lichen structure.

The whole question of the dependence of one organism, whether animal or plant, on another, or even others, again whether animal or plant, is every day becoming of greater interest. The views of various lichenologists on this matter are placed before us by Miss Lorrain Smith, but the simple word symbiosis is the term most favoured. It does not define the relationship between alga and fungus in too great a detail. Terms like helotism (due, by the way, to Warming and not to Nienburg), parasitism, consortium, endosaprophytism, and others, may cover certain individual cases, but the relationship of alga to fungus certainly varies in different species, or possibly even in different individuals of one species growing under different conditions. There is no doubt that on the whole the lichen-fungus fully controls growth and reproduction of the gonidial algæ,

though within certain limits both take place freely. Lindau, however, has described how in certain hypophlœodic lichens the alga actually forges ahead of the fungus.

The various branches of the subject have been very fully dealt with by Miss Lorrain Smith, but we think that not sufficient reference has been made to Exsiccata, which have played such an important part in lichenological nomenclature. We also consider that the book as a whole is not well illustrated. Many of the line drawings are quite inadequate as illustrations in a handbook of this standard. The half-tone figure on p. 117 appears to us to be *Cladonia uncialis* rather than *Cladonia furcata,* whilst Fig. 135 on p. 416 does not recall to us *Parmelia omphalodes,* which it purports to represent. Apart from these blemishes, which we consider rather serious, the handbook is a storehouse of valuable information, and Miss Lorrain Smith deserves the thanks of all lichenologists and botanists for the care and thoroughness with which she has completed her task. Some readers might possibly object that they are left too much to draw general conclusions for themselves.

The price of the book, unfortunately, is prohibitive except for public and college libraries.

(2) We are sure that Miss Lorrain Smith's "Handbook of the British Lichens" will answer its purpose very well and help both botanist and collector to name their specimens, instead of being compelled to depend for this on foreign books. The book, however, is only a key to the "Monograph of the British Lichens," by Miss Lorrain Smith, the price of which, again, is well-nigh prohibitive. We may express the hope that this little book will help to create renewed interest in a group of plants the study of which was at one time keenly followed in this country.

O. V. D.

British Mineral Resources.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. 19, *Lead and Zinc Ores in the Carboniferous Rocks of North Wales.* By Bernard Smith. Pp. iv+162+3 plates. 1921. 5*s.* 6*d.* net. Vol. 21, *Lead, Silver-lead, and Zinc Ores of Cornwall, Devon, and Somerset.* By Henry Dewey. Pp. iv+72. 1921. 2*s.* 6*d.* net. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd.)

THE two volumes under notice form an important contribution to our knowledge of British mineral deposits, and afford satisfactory evidence that Dr. Flett is continuing energetically the valuable series of reports inaugurated by his predecessor at the Geological Survey. The scheme of both volumes is identical and is upon the lines with which previous reports had already familiarised us, but the economic importance of the deposits discussed therein differs very widely. The lead and zinc veins of North Wales have not only been highly productive in the past, but also may well take rank in the future among the leading British lead-producing mines, whilst those of the south-west of England present little more than academic interest. Needless to say, none of the mines discussed in either volume is at work just now; in fact, in the whole of Great Britain there is not a single lead or zinc mine capable of working save at a loss at the present time, probably a result of Government interference in the control of industries.

In North Wales such well-known mines as the Halkyn mines and others in the Holywell-Halkyn area, the Minera mines and other adjoining mines in Denbighshire are fully described, together with numerous less important mining properties. It is abundantly clear that in all these cases the great difficulty to be overcome is the enormous influx of water, which has rendered the economic working of these mines practically impossible. An interesting account is given of the various deep adit drainage schemes by which it is proposed to unwater some of the more important mining areas down to a considerably greater depth than has hitherto been reached. Although he does not specifically say so, it would appear that Mr. Bernard Smith entertains no doubt of the ore holding down to the greatest depth that would thus be rendered available. Incidentally he shows that the 35,000*l.* which the Government advanced for unwatering the Halkyn area have been wasted and have never yielded any return whatever. It can only be hoped that some satisfactory scheme for unwatering this area may be devised and carried into execution, though it is difficult to see how this can be done until British lead-mining reaches a sounder economic position than that with which it is faced to-day.

As regards the lead mines in Cornwall, Devon, and the Mendip Hills, it can only be said that there is practically no likelihood at all of any serious revival of the lead-mining industry in these parts, and it is fortunate that the task of collecting information as to the past history of these mines has been undertaken before it is too late. Mr. Dewey has done a useful piece of work in carefully compiling an account of these mines, which will be especially interesting to the student of mineral deposition.

H. LOUIS.

Our Bookshelf.

Guide Pratique de Sylviculture. Par Dr. F. Fankhauser. Troisième édition française par M. Petitmermet. Pp. 348. (Lausanne, Genève, et Paris: Payot et Cie, 1921.)

DR. FANKHAUSER'S elementary text-book on forestry is used in Switzerland for the instruction of agricultural students and working foresters; that it has great merits is evidenced by its appearance in five German and three French editions. The work is remarkable for its clear style, excellent illustrations, and admirable choice of subject-matter. The introduction, concerned with the utility of forests, explains their importance in creating industries, in regulating water supply, in preventing erosion of the soil, etc., in a country like Switzerland, where there is so much of what the author calls "absolute forest soil," or land that cannot be put under any other form of cultivation. The forests of Switzerland cover, in fact, 2,300,000 acres, about 23 per cent. of the total area of the country, and are credited with a production of about 42 cubic feet of timber per acre annually.

The first part of the book—forest botany—after some elementary notes on morphology and physiology, deals separately with each forest tree, giving its botanical characters, distribution, reproduction, growth, sylvicultural features, enemies, diseases, wood, and other products. Only one foreign conifer is included, *Pinus strobus*, and it is evident that exotic trees, like Douglas fir, Sitka spruce, and Japanese larch, so much favoured in England for planting at present, are not valued in Switzerland as yet. The next part of the book, concerned with the art of sylviculture, is an excellent summary of the different kinds of forests and how they are created, maintained, and cared for. Much attention is paid to practical subjects, like choice, collection, testing, and sowing of seeds of forest trees, nursery treatment, artificial plantations, natural regeneration, and thinnings.

Other chapters deal with utilisation, a subject which includes felling and transport of timber, and the properties and uses of wood, and with the protection of forests from wind, frost, fire, drought, insects, fungi etc. The conclusion of the work is devoted to the simple engineering and building problems that are handled daily by foresters in Switzerland.

The Principles of Immunology. By Prof. H. T. Karsner and Dr. E. E. Ecker. Pp. xvii + 309 + 2 plates. (London: J. B. Lippincott Company, 1921.) 21*s.* net.

THE researches of Pasteur on immunisation against fowl cholera, swine erysipelas, anthrax, and rabies, and the discovery by Behring and Kitasato of the antitoxic properties of the blood serum, constituted the beginnings of the science of immunology, which since 1890 has grown to incredible dimensions and in every direction has insinuated itself into the domains of practical diagnosis and therapeutics. It is no longer within the capacity of one or even two individuals to deal authoritatively with the subject, although this was attempted, and with a fair measure of success, a year or two ago by such a master as Jules Bordet. Naturally many text-books exist on immunity, and the present work of Karsner and Ecker must be ranked as one of the more successful among these. The authors have handled a goodly part of the periodical literature, and have applied to their reading and study a critical acumen which is conspicuous by its absence in most books of this class. Their knowledge is of a most modern kind, and they have thrown over allegiance to the Ehrlich "side chain" hypothesis which dominated immunology for so many years. Naturally in a work of its size Karsner and Ecker's book is highly condensed, and is, in fact, restricted to fundamental principles. They state that it is primarily designed for medical students and busy practitioners. As a text-book for students working for the higher examinations it can be cordially recommended, and it may possibly be read with profit by the more intellectual types of practitioners who have previously prepared themselves for the intricacies of the subject by the perusal of some more elementary work on the subject.

We notice a number of misprints, especially in the names of several of the authorities cited, and it may be said that some of the few illustrations are crude. Otherwise it may be recommended as an accurate guide to those who wish to study the subject with profit in the periodical literature of the day.

W. B.

When Buffalo Ran. By G. B. Grinnell. Pp. 114 + 8 plates. (New Haven: Yale University Press; London: Humphrey Milford, Oxford University Press, 1920.) 10*s.* 6*d.* net.

THE supposed autobiography of a Red Indian boy of some seventy years ago, when the veteran author was himself a small boy. The tribe is not mentioned, doubtless with intention; but Mr. Grinnell probably had in his mind the Cheyenne, which he knows so well. Anyhow, the book is not for ethnologists, but for boys, and the one on whom we have tried it pronounces it "topping." Written in the simplest English, without affectation, the story brings out all the noblest features of the tribal life that has passed away. There is abundance of sympathy, but no sentimentality.

High Tension Switchgear. By H. E. Poole. (Pitman's Technical Primers.) Pp. ix + 118. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

IN this brief introduction to a large subject, the author contents himself with a summary of the principal features of present practice in the design of oil-break switches for the voltages in common use in this country. A few notes on isolating links, surge arresters, high-tension fuses, and testing pressures have also been inserted.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Atmospheric Refraction.

THE correspondence on terrestrial refraction from Mr. Mallock and Dr. de Graaff Hunter in NATURE of June 9, p. 456, and August 11, p. 745, raises a paradox which I think must have puzzled many readers of NATURE besides myself. Mr. Mallock is, of course, quite correct in stating that the diminution of density of the air observable under ordinary conditions is practically linear for moderate increases of height above the earth's surface, and that, consequently, the refractive index of the air may for moderate increases of altitude be taken as diminishing linearly at such a rate that it would reach vacuum value at the height H of the homogeneous atmosphere. Dr. Hunter is equally correct in pointing out that Mr. Mallock's reasoning, based on the above-mentioned observational fact, leads to a value of k, the coefficient of terrestrial refraction, which is almost exactly twice as great as that found by observation under ordinary conditions. Dr. Hunter does not, however, point out what I think is the real fallacy in Mr. Mallock's argument.

The difficulty is not to be got over by any consideration of temperature-gradient in the air, although it is well known that variations in the temperature-gradient constitute the chief cause of variations in terrestrial refraction. The only way in which temperature-gradient could affect Mr. Mallock's result would be by its requiring a change in the value (4·32 sea-miles) which he adopts for the height H of the homogeneous atmosphere. Whether we calculate H for air at a uniform temperature, as is usually done, or on the assumption of a diminution of temperature with increase of height at the rate ordinarily observable (say 1° C. for each 200 metres), we obtain a value of H which is nearly the same as that used by Mr. Mallock in his argument.

May I suggest that the solution of the riddle is to be found in Mr. Mallock's supposition of a "*plane vertical* wave-surface starting from P," whereas the rays of light from a terrestrial point must give rise to an approximately *spherical* wave-surface? In the diagram (Fig. 1), which represents a vertical section through the homogeneous atmosphere with the curvature of the earth neglected for simplicity, a plane wave-surface HPO would change its position to BAC in the time t, where HB and OC are proportional to the velocities of light at H and O. But in that time rays from a point P would reach points D and E, such that $PD-PA=\frac{1}{2}(PB-PA)$ and $PA-PE=\frac{1}{2}(PA-PC)$, because the average velocity along PD would be the mean of the velocities at P and H, and, similarly, the average velocity along PC would be the mean of the velocities at P and O. It is easy to see that this gives a radius of refractional curvature exactly twice as great as that found by Mr. Mallock, and consequently leads to a value for the coefficient of terrestrial refraction which is in agreement with observation and with the tables ordinarily employed by navigators for the dip and distance of the sea horizon.

It may be worth while to mention here a very likely source of confusion in comparing the values of the coefficient of terrestrial refraction k found by different observers under different conditions, and especially by observers in different countries. There are two definitions of k in use by surveyors, one of which makes its numerical value double that given by the other. An assistant of mine who read Dr. Hunter's letter was greatly surprised at his statement that $k=0·133$ "is *not* a value ordinarily met with in practice," because in Egypt we ordinarily use $k=0·13$, and our trigonometric levels derived from observations made in the afternoon hours when refraction is at its minimum and steadiest value are found to agree surprisingly well over great distances with those found by spirit-levelling. The explanation of the apparent discrepancy between Dr. Hunter's statement and our experience is that we follow the Continental practice in defining k as the ratio of the curvature of the refracted ray to the curvature of the earth, while Dr. Hunter and most English writers define it as half this quantity.

It does not seem to be very generally known that a rational formula for calculating the coefficient of terrestrial refraction at any point where the barometric pressure, air-temperature, and temperature-gradient are known was advanced by Jordan so long ago as 1876. This formula, which is given, together with an account of the theory on which it rests, in Jordan's "Handbuch der Vermessungskunde," Band 2, is

$$k=0·2325\,\frac{\mathrm{B}}{760}\,\frac{1}{(1+\alpha t)^2}(1-29·39n),$$

where k is the coefficient of terrestrial refraction, defined as being the ratio of the curvature of the ray to that of the earth, B the barometric pressure in mm., α the coefficient of expansion of air at constant pressure, t the air-temperature in degrees C., and n the temperature-gradient in degrees C. per metre of height.

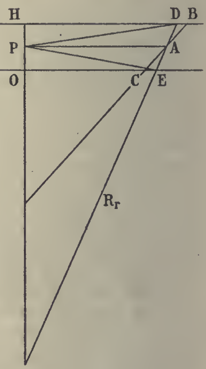

FIG. 1.

Jordan's theory is probably not quite complete, in that it omits any consideration of variations in the humidity of the air; but it does take account of variations of pressure, temperature, and temperature-gradient, and these are probably the principal factors affecting the value of k. The resulting formula is very simple and easy of application, and, so far as I have been able to test it in the Egyptian deserts, I have found it to give results which are in good agreement with those of observation. It appears also to accord very satisfactorily with Indian experience; for when applied in the two examples given by Dr. Hunter in his letter, one at sea-level and the other at an altitude of 19,000 ft., it yields (allowing for the difference in the definition of k) results identical with those which were found by Dr. Hunter to agree well with numerous observations. JOHN BALL.

Survey of Egypt, Cairo, December 14.

IN NATURE of June 9, p. 456, a letter appeared from Mr. A. Mallock giving a proof that the path of a nearly horizontal ray through the earth's atmosphere is a circle of about 14,900 miles' radius, and later (August 11, p. 745) Dr. de Graaff Hunter, of the Indian Survey, wrote controverting Mr. Mallock's statement, and asserting in effect that the radius of

the ray as deduced from measured values of the coefficient of refraction is distinctly higher, being about six and a half times the earth's radius, or about 26,000 miles.

Both letters contain an inadequate presentation of the facts of atmospheric refraction in that they assume that the path of the ray is circular. A very much fuller investigation is necessary in order to account for the distance of the visible horizon or its depression below the true horizontal.

Starting with the assumption that the atmosphere is in static equilibrium, leading to the differential equation $dp = -g\rho dh$, and with the pressure-density-temperature law $p = C\rho T$, a further assumption must be made before a complete solution can be arrived at giving pressure, density, and temperature in terms of height. A simple assumption to make is that of a uniform temperature-gradient expressed as $T/T_0 = 1 - \alpha h$. For the isothermal conditions $\alpha = 0$; for the adiabatic, α corresponds to a drop of 1° C. per 330 ft. increase in height. The integration of the general equation leads, provided h does not exceed 200 or 300 ft., to $p = p_0 - g\rho_0 h$ and $\rho/\rho_0 = 1 - (g\rho_0/p_0 - \alpha)h$. Since by Dale and Gladstone's law ρ is proportional to $n - 1$, we obtain without difficulty

$$n = n_0 - 0{\cdot}00029(g\rho_0/p_0 - \alpha)h.$$

Further, it is not difficult to show that with a ray that is nearly horizontal the radius of curvature σ is given by the approximate equation

$$1/\sigma = 0{\cdot}00029(g\rho_0/p_0 - \alpha).$$

This equation will give any value we like for σ provided we assume a suitable temperature-gradient. If we put $\alpha = 0$ (the isothermal state) we get substantially Mr. Mallock's figure. If we take the adiabatic gradient the radius is about 20,000 miles. If we take a fall of temperature of 1° C. per 200 ft., Dr. de Graaff Hunter's value results. A gradient of 1° C. per 100 ft. gives a flat ray and an atmosphere of uniform density. To obtain greater curvatures than Mr. Mallock's figure the temperature-gradient must be reversed.

It is no use to take this formula and expect it to be uniform over even very narrow levels when close to the surface of the sea. The temperature-gradients in the first 30 ft. (the average height of the bridge of a ship above the sea) are very frequently greater than any of the gradients mentioned above, and show wide variations in that space. In such case the path of a ray from a visible object more than a mile away is nothing like circular, but may have variations in its curvature of 300 or 400 per cent. I am aware that the value of the coefficient of refraction mentioned by Dr. de Graaff Hunter is used in books of nautical tables in computing the dip and distance of the sea horizon, but I am aware also that actual measurements of the dip at sea show that tabulated values are frequently in error, sometimes even of the wrong sign! Measurements made by Blish off the coast of California showed that a zero dip is quite possible. In the Red Sea the sea horizon is often refracted above the true horizontal.

Consider the path of the ray of light from the horizon to the observer's eye when the dip is zero. The path touches the earth's surface at the horizon and touches a concentric sphere of perhaps 30 ft. greater radius at a point only six or eight miles away. The radius of curvature of the ray must be greater than the earth's radius at the horizon and smaller at the observer—a maximum at the first point and a minimum at the second. Neither Mr. Mallock's figures nor Dr. de Graaff Hunter's can deal even approximately with a ray-path of this nature, and I think it may be asserted without question that to take adequate account of the path of rays of light through the lower levels of the atmosphere demands consideration, not only of the curvature of the ray-path, but also of the first and second differentials of the curvature.

THOS. Y. BAKER.

Admiralty Research Laboratory, Teddington, Middlesex, December 22.

The Message of Science.

Two great questions are raised in the abridgment given in NATURE of December 22 of the notable address delivered by Sir Richard Gregory during the Edinburgh meeting of the British Association. They are:—(1) How can an interest in, and respect for, science in all its branches, with their essential unity, be developed locally? (2) How can the work of the British Association be so broadened and improved as to ensure that it will yield—to use the words of Sir Richard Gregory—"a statement of ideals and of service, of the strength of knowledge and of responsibility for its use"?

Local scientific societies consist of three types:—(1) Sectional bodies interested in general engineering problems or in the technical details of certain sciences applied to the chief industries of the district. (2) Natural history societies or field clubs. (3) Literary and philosophical societies which provide in a few large towns a good library and series of winter lectures.

With regard to the first type little need be said. They fulfil their specialised functions fairly well, but their work would be greatly improved, and made gradually more attractive, if it were possible to secure an outlook on the broad field of science. Sir Richard Gregory said in the course of his address in Edinburgh: "Whatever Labour may declare officially, it is scarcely too much to say that artisans in general show less active interest in scientific knowledge now than they did fifty years ago." This statement is true, not of artisans only, but of all classes. The demand has been made on science: "Make us rich and comfortable." Science, in a large measure, has responded. But with wealth and comfort has come a lessening of respect for knowledge. The highest things that science can give—an ardour for truth, the power to rise above sordid interests, the desire to become co-workers in an infinite process by which soul is drawn from matter—have been set aside, and we have been landed in a back-wash.

I do not think any revolutionary changes are necessary locally in order to bring back the enthusiasm which linked science a generation ago to human liberty and human justice. Sir Richard Gregory speaks of a federation of local societies "to proclaim the message of knowledge from the housetops." It may be necessary, first of all, for these societies to find out what the real message of knowledge is, but they need not wait for perfect vision; much can be done while they are only groping.

What is wanted, above all things, is such an infusion of earnestness as will arrest the displacing power of the mere lantern lecture. The lantern has been a good servant, but it is threatening to become a bad master. At present the great trouble of the secretary of a literary and philosophical society is to make his organisation pay its way. The chief thing for which the organisation stands is often sacrificed in the attempt to secure popular support. This attitude must be abandoned even if abandonment leads into the wilderness. The message of science will come back from there with renewed constraining power. There are thousands waiting for the message. What

stands in their way is the lack of faith and of courage on the part of the present directing agencies. Probably the most practical suggestion of immediate value that has been made is that the various scientific societies in any town should arrange meetings for study and discussion—the discussion which seeks agreements and does not emphasise differences—and that the underlying, but not obtrusive, object of the meetings should be the progressive connecting of science with individual and corporate conduct.

The second question has many factors in common with the first. The British Association has suffered from the mental reaction which set in a quarter of a century ago. It is a much smaller factor in the thought and life of the age than it was a generation ago. I think the first helpful change desirable is the recognition of a new principle in the selection of a president and in the making of his annual address. Above all things, the president should stand for the unifying of the sciences, and his address should make some definite contribution to that unity, even when it is built largely on the recent achievements of one section of knowledge.

It is only through a conception, becoming ever clearer, of this unity that science can become the "chief formative factor of modern life." The yearly appeal of a president may do much, but more would be achieved if a day were set apart for the study or discussion of the thoughts and facts he has communicated—a study or discussion, I say again, which should emphasise agreements and not differences.

Progress in this direction might receive a healthy impetus from the universities. They, too, have lost a considerable amount of influence. They are not, at home or abroad, leading humanity. The note of real universality is departing from them. Here again the first practical improvement will come from the manifestation of greater care in the selection of the principals of the attached colleges. They ought to be something more than skilled administrators. They, too, have a great unifying function.

This unifying work might be facilitated if there were periodical meetings of the various professors and lecturers for the study of unifying problems. That does not, I admit, promise to help them immediately to overcome the financial difficulties which are now laming them to a terrible extent and driving them to seek greater support from an overburdened State. But if the universities, encouraged by a steadily increasing enthusiasm for science locally and centrally, were themselves to become again great inspirers of thought, they would soon cease to be troubled by the lack of pence.

W. ROBERTSON.

Middlesbrough, December 29.

Cohesion.

THE theory of cohesion put forward by Dr. Herbert Chatley in NATURE of August 18 is logically based on those of other investigators, and, consequently, does not involve any new element. In all these theories cohesion is made to depend on centrally directed forces which follow either the inverse square law of gravitation or electrical attraction, or that of some other inverse power higher than the second. Dr. Chatley says: "It is difficult to conceive of one force having all these properties, but perfectly simple to imagine an attraction and repulsion combined that will do so, provided that *the attraction decreases more slowly with separation than the repulsion.*" He takes the ground that the force of cohesion as stated by him is related to those following the inverse square law, and that the question of the relation between them is of great importance.

Now it is a matter of common observation that two free liquid spheres on coming into contact with each other always coalesce. The force which causes this is evidently a force *enveloping* their masses, and not a force attracting them. This enveloping property of surface tension was noticed by Maxwell and others; but the theory which makes it depend on molecular attraction renders it impossible to conceive of such a force as enveloping *molecular* masses.

The present writer has adduced (*Phil. Mag.*, June, 1921) very strong, if not conclusive, evidence that the same force which causes liquid spheres to coalesce also causes the free molecules of a gas to coalesce or cohere. It cannot, therefore, be explained by molecular attraction. The alternative is that *it is an elemental force acting, not in lines, but over areas.* As such it is a universal property of the surface of both liquid and solid mass extending to molecular dimensions.

Fortunately, however, there is very definite and easily verifiable evidence that cohesion, and adhesion also, is due to a surface force, whatever its nature may be, as can be seen from the following simple experiments which will be published later in fuller detail.

Spheres of mercury, ranging from 0·05 mm. to 1·5 mm. in diameter, were hung from a drop of water wetting a glass surface above. Each one fitted into an inverted hemispherical cavity in the water, with a well-defined angle in the contact circle where the water surface joined the mercury surface. With a specially adapted microscope the diameter of the sphere, the width of the contact circle, and the angle between its water arm and the vertical were measured. From these measurements, W, the weight of the mercury sphere, and T, the vertical component of the pull of the water surface on the mercury, were calculated for a large number of spheres. The results showed that for small spheres T greatly exceeded W, but tended to become equal to W when the spheres were at the point of falling off. The ratio T/W decreased gradually from about 6 to 1, thus showing that the surface force of the water pulling on the mercury in the periphery of the contact area was more than sufficient, except in the limit, to support the weight.

Similarly, mercury spheres, with diameters from 0·05 mm. to 2·25 mm., were suspended from a horizontal glass surface. They were attached to the glass either directly or by suspending them from water as before and allowing the water to evaporate. The mercury surface was joined to the glass surface in the periphery of a wide circular contact area, and formed a definite angle with the glass surface. Measurements were made as before, and W and T (for mercury) were calculated. The results showed that, as the spheres increased throughout the range, the ratio of T/W decreased from the surprisingly large number of more than 6000 to about 2. Had T, however, been calculated from $\sigma=270$ instead of $\sigma=547$, the decrease would have been from about 3000 to 1 as before, and hence 270 may be regarded as an approximate value of the surface tension of glass. The increasing values of T/W for the smaller particles would account for the persistence with which molecules of a gas condense on a glass surface.

Further, small particles of any insoluble solid become attached to any surface above by the evaporation of a connecting water drop; or, if the particles be clean and small, they become attached to any clean surface by simple contact with it. This is amply confirmed by extended observations.

Now there is no reason to think that the force of cohesion is not of the same nature in the case of two solids as it is in the cases of a liquid and a solid and

of two liquids. Moreover, as it has been shown that two free molecules of a gas cohere (coalesce) from this same cause, it is justifiable to conclude that in all cases down to molecular dimensions cohesion is simply *a surface force pulling in the periphery of the contact area perpendicularly to that area.* It may be remarked also that these results furnish no evidence of the so-called molecular attraction.

By calculation this force binding two molecules of water together is $2{\cdot}05 \times 10^{-5}$ dynes; of mercury, $7{\cdot}7 \times 10^{-5}$ dynes. These agree with Dr. Chatley's statement that (molecular) cohesion is of the order of 10^{-6} dynes. Again, in the case of two molecules cohering in this manner the enveloping force can have a range not greater than two molecular diameters, while for larger molecular masses the range may be as great as three or four molecular diameters. It thus fulfils the condition for the range of action. In comparison with their gravitational attraction this force binding two water molecules together is of the order 10^{33} times as great. It is of the same order as the electrical attraction of two oppositely ionised molecules just before they come into contact. It causes a pressure on the interior molecular mass of the same order as the intrinsic pressure of the liquid. It does appear, then, that one force can be conceived as having all the properties of cohesion.

The conception of this force as a cause of molecular phenomena appears to be, in fact, fundamental. It solves the problem of surface tension; it explains, as we have seen, both cohesion and adhesion, and it accounts satisfactorily (*Phil. Mag., ibid.*) for the latent heat of condensation. But besides all this there is the remarkable coincidence that the force itself is located, or performs its function, in the precise area bounding free mass that the phenomena of reflection and refraction of light take place and electrons have their movement. These considerations give point to Dr. Chatley's concluding words: "It would appear that a complete solution of the macroscopic properties of matter would also solve the question of the inner structure of the molecules and atoms."

WILSON TAYLOR.

Physics Laboratory, University of Toronto,
Canada, November 15.

The Resonance Hypothesis of Audition.

ADDITIONAL evidence in favour of the resonance hypothesis of audition has been found recently.

The study of long-distance telephony has shown that low-pitched notes travel more rapidly than do those of high pitch, owing to the impedance of the electrical circuits. Mixed tones must, therefore, arrive with phase relationships between the high and low tones quite different from those with which they started.

In spite of this, even such complex sounds as those composing human speech are found to suffer but small apparent change in quality and distinctness during transmission. And this statement appears to apply equally to wireless telephony, where similar changes of phase must occur.

These facts suggest that the ear responds to tones quite independently of their relative phases, and therefore that true harmonic analysis must take place in the organ of Corti. A survey of the different types of harmonic analysers used in physics, for tide production and the like, shows that such harmonic analysis is invariably performed by a series of some type of resonator. Presumably, therefore, since the ear can carry out harmonic analysis, it also must contain resonators.

To test the premises more thoroughly the following experiment was carried out:—

Two electrically driven tuning-forks, emitting pure tones, were connected to separate battery and switch circuits, and were mounted on separate tables, so that while they vibrated independently their tones entered the ear of the observer simultaneously. They were tuned so that their tones had rates of vibration in the ratio of 1 and 3, this ratio being chosen because of all pairs of tones these give the largest changes in the form of the sound wave-curve as the relative phases of the tones are changed. Thus with one phase relationship the sound wave-curve has a single sharp, well-marked peak, whereas with another phase relationship two peaks are found, having a trough between them. If, then, the ear is affected at all by the form of the sound wave-curve, these two tones, combined in different relative phases, should show it. The experiment was performed by causing the higher-toned fork to sound continuously, the lower-toned one being turned on and off at irregular intervals, so that the relative phases should be chance ones. No difference whatever in the quality of the sound could, however, be detected by the observer. The response of the ear appeared to be quite independent of the relative phases of the tones, and, therefore, we must conclude that the ear effects a true harmonic analysis by means of resonators.

If the above experiment is repeated with two sources of tones that are not free from overtones it is found that the ear does readily detect differences in the quality of the sound as the relative phases of the tones are altered. For example, if Helmholtz's syren is used with, say, 18 holes operating in the lower wind chest, and 6 holes in the upper, then there are found to be 18 regularly spaced positions where the lower tone predominates, and 18 intermediate positions in which the upper tone predominates.

These effects are produced by the summation and interference between the upper tone and the second harmonic overtone of the lower tone. When holes of both wind chests are exposed simultaneously, summation occurs, and the upper tone predominates, whereas when the holes of one chest alternate with those of the other, interference occurs which weakens the upper tone, so that the lower tone predominates.

Many years ago there was considerable controversy as to whether the ear could, or could not, detect difference of phase. The above experiments suggest that pure tone free from harmonics may have been used by one school, and impure tones containing harmonics by the other, because in this way their difference in opinion could be readily explained.

C. R. G. COSENS.
H. HARTRIDGE.

King's College, Cambridge.

The Action of Sunlight.

IN NATURE of December 15 Sir Oliver Lodge is good enough to refer me to some experiments on the antiseptic action of sunlight which he carried out long ago in association with the late Prof. Marshall Ward. I have not yet been able to see the memoir to which Sir Oliver Lodge refers, but I believe that I am already well acquainted with it, and have been able to quote its essential findings on many occasions in connection with the demand for the abolition of the coal-smoke curse—thanks to an admirable account of Marshall Ward's methods and results, referred to the year 1892, in Sir James Crichton-Browne's "Light and Sanitation," an address delivered in Manchester in 1902 (Sherratt and Hughes, 27 St. Ann Street, Manchester). Particularly I value the last paragraph, in which Sir Oliver Lodge praises the anti-

septic and innocent quality of the sunlight just as we get it after filtration by the "unpolluted atmosphere."

But after seeing the clinical action of sunlight at Leysin under Dr. Rollier and at the Treloar Hospital under Sir Henry Gauvain, and reading the papers of Sonne (*Acta Medica Scandinavica*, vol. 54, fasc. 4, "The Mode of Action of the Universal Light Bath," from the Laboratory of the Finsen Medical Light Institute, Copenhagen) mentioned in my previous letter, I am absolutely certain, as anyone else would be, that there is more in the curative action of sunlight than its bactericidal effect. In a recent lecture before the Physiological Society of University College, entitled "The Physiology and Therapeutics of Sunlight: Facts and Questions," I cited instances and showed photographs of many cases where the value of sunlight could not have depended upon its antiseptic power. Sonne's view is that sunlight warms the blood without appreciably raising the general body-temperature, that this produces the valuable, without the injurious, effects of fever, and that this action is obtainable by the proper use of sunlight, and by that alone.

The practical importance of this fascinating physiological problem is apparent to me after recent visits to certain sanatoria, otherwise admirable, where I have been told that I should see the sunlight employed, and have found, for instance, that open air and diffused daylight, the latter reaching the face and possibly the hands, were regarded as the equivalent of Rollier's treatment; or that the children were scrupulously put under awnings or sent to school in an adjacent wood whenever the sun shone. The pitiful statistics of these places, compared with those of Rollier and Gauvain, point the moral.

Since first drafting this letter I have seen, thanks to Prof. Leonard Hill, new records of work done by Prof. A. F. Hess in New York, showing the cure of experimental rickets in animals fed and continuing to be fed on a diet which invariably produces rickets—when they were placed in sunlight for a few hours daily. No mere antiseptic action is here in question.

With rare exceptions, we do not yet know what heliotherapy consists of in this country; no one yet knows its action, nor even the pure physiology of sunlight. Meanwhile, we are carefully depriving many patients of their one chance of life, and quacks and others are using all manner of artificial lights in therapeutics as if they were equivalent to, or better than, the sunlight, which, according to Sonne's experiments—nicely consorting from another point of view with those of Sir Oliver Lodge—is incomparable.

The Smoke Abatement Committee has now published its admirable Final Report, and reiterates now my plea for an inquiry such as Carrel, I am told, is about to undertake at the Rockefeller Institute in New York, but which no one, not even Prof. Leonard Hill, our great student of the air and temperature relations of the body, is yet making here into the action of sunlight. I believe that the restoration of sunlight to our urban populations, mostly darkened in slums and smoke, is the next great task of hygiene in this country.

C. W. SALEEBY.

Royal Institution, January 2.

Units in Aeronautics.

A LARGE number of equations in aerodynamics appear in the form $R=k\rho SV^2$, where R, ρ, S, V are the reaction, density of the atmosphere, surface, and relative wind velocity.

Since both R and ρSV^2 have the dimensions of force, k is clearly a numerical coefficient unchanged by transformation from one self-consistent system of dynamical units to another, *e.g.* from foot, pound, second, poundal to centimetre, gram, second, dyne.

In transforming to an inconsistent system, k will in general be altered, but the inconsistencies may cancel each other in particular cases so far as to leave k unaltered. For example, if a gravitational unit of force is introduced g times the consistent unit, then we may write $R=k\rho SV^2/g$ pounds *weight* in the British system, or grams *weight* in the c.g.s. system. And while the numerical values of both R and g vary inversely as each other, the value of k is not affected if the system is otherwise consistent.

Prof. Bairstow ("Applied Aerodynamics," p. 119) maintains that the gravitational unit of force is the natural one, and to get rid of the local value of g that mars the consistency of his dynamical equations he introduces a new unit of *mass*, the "slug" of (local) g pounds mass, the use of which he restricts to the measurement of atmospheric density. Then putting $\rho'=\rho/g$ he can write $R=k\rho' SV^2$ in the same form externally as before, and read off the value of R in pounds weight instead of in poundals, all without showing g explicitly.

In this way, in his opinion, "it appears that the divergence of language (*sic*) between science and engineering would disappear."

But if we apply this method of measuring the density of the atmosphere to the estimation of the lift of an aerostat we get, putting m=density of hydrogen/density of air, $(1-m)\ \rho'\times$volume$=$R *slugs weight* ($=g$R pounds weight$=g^2$R poundals!).

Altogether it seems more satisfactory to teach engineers the physical meaning of Newton's laws of motion than to invent units which evade them, just as it has proved better to teach them the elementary notation of the infinitesimal calculus than to devise "calculus-dodging" demonstrations.

A. R. LOW.

London, December 8.

Self-fertilisation in Mollusca.

As the question of self-fertilisation in the more highly organised invertebrates is of considerable importance from the genetic point of view, I would like to direct the attention of readers of NATURE to a publication (Acta Soc. pro Fauna et Flora Fennica, vol. 40, No. 2, 1915), a copy of which I have just received from the author, Dr. A. Luther. It constitutes an important addition to the evidence for the occurrence of self-fertilisation in mollusca, as Dr. Luther states that he succeeded in rearing two generations by self-fertilisation in *Agriolimax agrestis*. I have recently pointed out (Proc. Malac. Soc., vol. 14, 1921) the value of Künkel's work on Arion in this respect; but at the time Dr. Luther's results were not known to me, as the publication was not available and had not figured in the "Zoological Record." Should these important observations be finally confirmed and the technique improved so as to produce more than two generations, a very valuable contribution to genetic study will be achieved. Dr. Luther's work, however, emphasises the necessity for conducting a study of environmental conditions in order to secure improved viability.

I may point out, perhaps, that though quite a number of cases of self-fertilisation have been recorded in Pulmonata by Lang, Holzfuss, and others, the subject is by no means fully explored either with regard to the distribution of the phenomenon among Pulmonata or the circumstances in which it occurs.

G. C. ROBSON.

British Museum (Natural History),
Cromwell Road, London, S.W.7, December 23.

The Law of the Heart.[1]

By Prof. E. H. Starling, C.M.G., F.R.S.

THE discovery by Harvey of the circulation of the blood, and of the part played by the heart in carrying on this circulation, is one of the few scientific discoveries which have become common knowledge. We have to think of the body as a collection of mechanisms or machines, each one of which is doing some form of work for one common end—*i.e.* the preservation of the body. For this work the oxidation of the food taken in at intervals during the day provides the energy; thus each part of the body must be supplied not only with food derived from the alimentary canal, but also with the oxygen taken in with the air we breathe into the lungs. Like any other machine, each body mechanism produces, as a result of this consumption of the food, waste gases and other waste products which have to be carried to the lungs or to the kidneys and there cleared out of the body. It is for this reason that the existence of the higher animal demands a common fluid, the blood, which can carry food, oxygen or carbonic acid, and is maintained in continual circulation between all the organs of the body, so that the alimentary canal, for instance, may serve for the maintenance of all parts, and the lungs can supply oxygen to these parts or excrete the carbonic acid which is produced as a result of their activity.

But a uniform mechanical circulation would be of little value to the body, since the activities of all its parts vary within wide limits. Thus, during muscular exercise the activity of the muscles may be increased tenfold or more, and this increase means a corresponding augmentation in their call for oxygen and in the quantity of waste products, especially carbonic acid, that they produce. Since the oxygen is carried by the blood, it follows that for the continued functioning of the muscles these must receive a blood supply which is ten times greater during activity than during rest if their activity is not to be brought to an end by a species of suffocation. Therefore, in any violent exercise involving the greater number of the muscles of the body, the circulation must be increased in force seven to ten times, and the heart, which is the pump maintaining the circulation, must under these conditions do from seven to ten times as much work as during rest.

The Mechanism of Adaptation.

What is the mechanism of these adaptations? How is it that the heart is able to carry on a circulation which may vary from a passage of 3 litres of blood per minute up to 30 litres of blood per minute (these figures representing the extreme limits between which the output of the heart-pump may vary according to the condition of the body)? It might be thought that we are dealing here simply with the influence of the central nervous system, which adapts the activity of the muscles of the body to the requirements of the environment, and that the heart being a muscle would be stimulated to contract more strongly at the same time as the nervous system calls into activity the voluntary muscles of the body. There is no doubt that the heart is under the control of the central nervous system, so that its action can be altered, increased, or diminished by the brain in accordance with the needs of the economy, but in the heart we find also a wonderful power of adaptation to the varying requirements of the organism which is quite independent of the central nervous system.

This can be shown quite easily either in the cold-blooded or warm-blooded animal. The heart of the frog and tortoise can be cut out and will continue beating for hours or even days. It has long been known that the heart of the mammal would beat for some minutes after being cut out of the body, but if we take pains to ensure that the muscles constituting the walls of the heart continue to receive their supply of oxygenated blood, the mammalian heart can be made to beat for eight to twelve hours after the death of the animal from which it is taken. In order to investigate this properly we want to make such a preparation that we can control at will all the conditions which may affect the action of the heart—viz. the amount of blood flowing into the heart from the big veins, the resistance which the heart has to overcome when it drives the blood out into the arteries, and the temperature at which the heart contracts. We must be able to measure at any time the output of the heart, the arterial pressure it maintains, its changes in volume during contraction, the pressure in all its cavities during contraction, the amount of blood flowing through the blood vessels of its walls, and its chemical exchanges, as measured by the amount of oxygen which it takes up and the amount of carbonic acid which it produces. It is these chemical changes which give the energy for the work of the heart.

The Heart-Lung Preparation.

All these procedures and controls can be carried out in the heart-lung preparation. In this preparation the pulmonary circulation from right ventricle to left auricle is left intact, and by means of artificial respiration the lungs are blown up rhythmically so that the blood in its course may take up oxygen and get rid of carbonic acid. The whole systemic circulation is replaced by rubber tubes. A glass tube is tied into the largest branch of the aorta, all the other branches being tied, so that the blood driven out by the left ventricle can escape only by the glass tube. From the glass tube a rubber tube passes to a thin rubber tube container within a wide glass tube. This thin rubber tube can be compressed to any desired extent by pumping air at a known pressure into the glass tube

[1] Discourse delivered at the Royal Institution on Friday, May 20, 1921.

surrounding it. We can thus vary at pleasure the resistance which has to be overcome by the left ventricle, and, by maintaining a normal pressure in the beginning of the aorta, ensure a proper supply of oxygenated blood through the coronary arteries to the muscular tissue of the ventricles. It is this fact which makes it possible for the warm-blooded heart to continue to beat for eight to twelve hours after removal from the body. On the other side of the artificial resistance the blood is led through a spiral immersed in warm water to keep the blood at body temperature, and then passes into a reservoir from which a wide rubber tube leads to a glass tube placed in the big vein opening into the right auricle. By means of a screw clip on this tube the inflow of blood may be regulated to any desired extent, and can be kept constant while other conditions are varied. Thus in this preparation the three chief factors, temperature, the inflow of blood, and the resistance to the outflow of blood, can be varied separately and at the will of the operator. Any of the heart cavities or any part of the circuit can be connected to manometers so as to record the pressure of the fluid, and by means of a side tube placed just beyond the artificial resistance we can allow the blood to flow off into a graduated cylinder, and thus measure the time taken by the left ventricle to expel 50 or 100 c.c. of blood, thus measuring the average output of the organ.

An Experiment Described.

A typical experiment may be divided into six stages. Records of one experiment show that in the first stage the heart was beating at a normal rate (72 per minute), the blood pressure varied from 100 mm. Hg, and the output of the heart was 240 c.c. of blood per minute. In the second stage the resistance to the flow of blood through the tubes was increased to such an extent that the pressure rose to 160–180 mm. Hg. The heart continued to beat, and for a time put out just as much blood as it did at the lower pressure. In the third stage the artificial resistance was suddenly reduced to zero, the arterial pressure fell to about 20 mm. Hg, but the heart beat regularly and the outflow of blood was unaltered because the inflow of blood had not been altered. In the fourth stage the inflow of blood was raised suddenly to 600 c.c. per minute. The heart became bigger, but the regularity of its contractions remained unaltered, and it drove forward all the blood that it received.

The same thing happened in the fifth stage, in which the artificial resistance was raised simultaneously with the venous inflow. The reason for these phenomena is that within certain limits the heart isolated from the body can respond to all the demands made upon it; it can overcome a higher resistance, and it can pump out more fluid. In the sixth stage the inflow of blood was further increased to 1200 c.c. per minute, and the artificial resistance was increased until the blood pressure rose to 200 mm. Hg. This was too much for the heart, which began to beat irregularly and dilate widely. It would have failed altogether if the pressure surrounding the thin rubber tube had not then been released to allow the artificial pressure to drop to a level at which the left ventricle could empty itself.

If during this experiment the amount of oxygen taken up by the blood had been measured, and also the amount of carbonic acid given off by this fluid in passing through the lungs, an increase in both these amounts would have been found during the stage at which greater demands were being made on the heart. That is to say, the greater the work done by the heart, the greater the chemical changes to supply energy. A motor-car may be running steadily with an even beat of its engines along a level road; when it comes to a hill it will slow up and finally stop unless the chauffeur increases the chemical changes and the energy of each explosion within the cylinder by opening the throttle and letting in more mixture of petrol and air. In the case of the heart there is no chauffeur, but there is some automatic regulation by which the heart increases its chemical changes, and therefore the energy of each beat, in exact proportion to the work which is demanded of it. It is the nature of this automatic regulation which concerns us now.

The Nature of the Automatic Regulation of the Heart.

By a careful observation of the changes in the heart in the experiment described above we may arrive at some clue to the nature of the pressure, but more accurate methods are necessary if we are to be certain of the correctness of our guess. We must, under these varying conditions, measure: (1) the pressure in the heart cavities produced at each contraction; (2) the volume of the heart cavities—*i.e.* the length of the muscle fibres of their walls. The first we measured in the experiment described by connecting the interior of each cavity in turn with a quickly acting manometer, the excursions of which are registered by an optical method so as to avoid the instrumental vibrations of a lever. The curve of pressure obtained under two conditions—*i.e.* low and high artificial resistance—could then be plotted. It must be remembered that the heart was sending on in each case all the blood that it received, though the work necessary under the high pressure was two or three times as great as that necessary to send on the blood at the low pressure. To measure the volume of the heart the ventricles are enclosed in an instrument known as a cardiometer. This communicates with a piston recorder so that the change of the volume of the ventricles at each beat can be registered on a moving surface.

The question we have to decide is: How does the heart know when it is relaxed that at the next contraction it will have to exert more force than it did previously, when the arterial resistance to be overcome was lower? If we measure the pressure in the ventricles in the manner just described we find that during the period of relaxation of the ventricles the pressure in its cavities is approximately zero, whether the artificial pressure which it has to overcome at its next beat is 50 or 150 mm. Hg. It

is not, therefore, the tension on the walls of the heart which determines the strength of its contraction at its next beat. When, however, we come to measure the volume of the heart, we find that in the isolated heart this is directly proportioned to the work which the heart has to accomplish. Thus we find that the larger the heart—*i.e.* the more it is dilated during diastole—the greater is the pressure that it will get up at the succeeding contraction or systole.

We may put this in another form, as is shown by continuing our experiment over several hours, when we find that the worse the condition of the heart muscle, the more it must dilate in order to get up an adequate pressure. Other things remaining equal, we thus see that the volume of the heart during diastole is a measure of its physiological condition, and we are not surprised that a failing heart means a dilated heart. Of course there is a limit to this power of adaptation. As the heart dilates it is working at an ever-increasing mechanical disadvantage, and a point will finally arrive at which this disadvantage more than counterbalances the physiological effect of dilatation. The heart then dilates widely and fails to empty its contents. Dilatation of the heart means elongation of the muscular fibres composing its walls, so that we may put the law of the heart another way and say that the longer its muscle fibres the greater is the energy developed at each contraction. But in this form this wonderful power of adaptation possessed by the heart becomes part of the general properties of all muscular tissues, since the same rule applies to the fibres composing our voluntary muscles. Can we obtain any more precise and physiological conception of what is involved in this relationship between length of fibre and strength of contraction? Microscopic examination of the fibres, either of the heart or of voluntary muscle, shows that these are composed of innumerable fibrils, so that internally the muscle is made up of structures presenting an enormous extension of longitudinal surfaces. The more the muscle is stretched, the greater will be the extent of these surfaces. A large amount of evidence, based on the electrical and chemical changes occurring in muscle as a result of excitation, points to the contraction as being essentially a surface phenomenon—a molecular change over the whole of the longitudinal surface which may result in a polarisation or depolarisation of the surface and an increase of surface tension, so that the muscle is a surface tension machine in which there is on excitation a direct conversion of chemical into surface energy. The greater the surface the greater will be the number of molecules involved, so that increased length of muscle must increase at the same time the total chemical changes and the total tension produced by the summation of the surface tension of each fibril.

It is only by such a change of molecular dimensions that we can explain the rapidity of events in a muscle (the insect wing muscle can contract and relax 300 times per second), or the high efficiency of the machine, an efficiency which A. V. Hill has shown may amount to 100 per cent. for each isolated contraction, and over a length of time to 50 per cent. As directly measured in the heart-lung preparation, we find a mechanical efficiency of about 25–30 per cent.

Conclusion.

It is impossible here to enter into the applications of this law of the heart, but so far it has not failed in accounting for the behaviour of this organ under all manner of conditions, either in health or disease. It is important to remember, however, that we are dealing here with the isolated heart. In the natural body the mechanisms which we have studied are fenced round, protected and aided by the complex activity of the central nervous system, which is always acting on the heart, balancing its activity against that of the blood vessels, and co-ordinating it with the events which are occurring in every other part of the body. All these factors must be taken into account when we are endeavouring to form a conception of the total behaviour of this organ under the varying activities of the intact animal.

A Summer Visit to Jan Mayen Island.

By J. M. WORDIE.

JAN MAYEN ISLAND lies in 71° N. latitude, 8–9° W. longitude, and is approximately 300 miles north of Iceland, 200 east of Greenland, and 600 west and north-west respectively of Tromsö and Aalesund—the leading hunting ports in Norway. It was possibly discovered in 1607 by Henry Hudson and named "Hudson's Tutches"; the name, nevertheless, by which it is now known commemorates a Dutch seaman, Jan Jacobsz May, who visited the island in 1614. The evidence for the earlier visit by Hudson can scarcely be regarded as trustworthy. May's voyage, on the other hand, is well supported by documentary evidence. Immediately following its discovery, Jan Mayen became frequented almost every year by rival Dutch and British whalers. As a whaling and sealing centre, however, the island was markedly inferior to Spitsbergen. Its importance was, nevertheless, far from small, and the British Government is said to have made a grant of it to the Corporation of Hull in 1618. The number of whalers frequenting the island, however, dropped off very considerably about 1635, the immediate cause being probably a series of bad ice years.

Scoresby was the first to give a scientific account of the island. His narrative was based on a visit in 1817, when he was ashore for a short while and climbed one of the smaller extinct craters. Berna and Vogt in 1861, Mohn in 1877, and Rabot in 1892 also published descriptions. The only expedition last century which remained any length of time on the island, however, was that of the Austrian International Circumpolar Station in 1882–83. During a fourteen months' stay under Wohlgemuth's leadership the party made full magnetic and meteorological records. Their map, which we found very useful and accurate, was the work of von Bobrik. Curiously enough, the natural history was very slightly studied.

Last summer's expedition was originated by J. L. Chaworth-Musters at the beginning of last year; the objects were partly to climb Beerenberg, a mountain more than 8000 ft. high, and often stated to be a still active volcano, partly to complete the Austrian survey of the island by investigating more minutely its geology and natural history. Musters originally intended to charter a hunting sloop from Aalesund. This, however, proved unnecessary through the establishment of friendly relations with a Norwegian engineer, who, under the auspices of the Norwegian Government, was hoping to establish a wireless station for meteorological purposes either last year or this. A satisfactory arrangement was made, and our expedition secured passages in Engineer Ekerold's two ships *Polarfront* (24 tons) and *Isfuglen* (54 tons). On the Norwegian side the affair was now pushed with greater vigour than ever, and after innumerable difficulties Ekerold finally was able to carry his plans into execution.

At Bergen we were met by Prof. Mercanton, of Lausanne, who had long wished to climb the mountain, and it was arranged that on reaching the island he should transfer from the Norwegian party to ours. We were now strongly represented in the various branches of science. Musters himself undertook botanical collections, Bristowe and Lethbridge the natural history, and Mercanton's knowledge of glaciology and mountaineering made him a valuable recruit. The party of six was completed by Richmond Brown as "campman," and myself as geologist. Four of us were members of Cambridge University.

After a somewhat rough passage the island was reached on August 7. It was much too late to think of studying the nesting habits of the birds. It was almost too late to find the plants still in flower. Musters, therefore, accompanied by Bristowe, at once commenced his collecting. The lateness of the

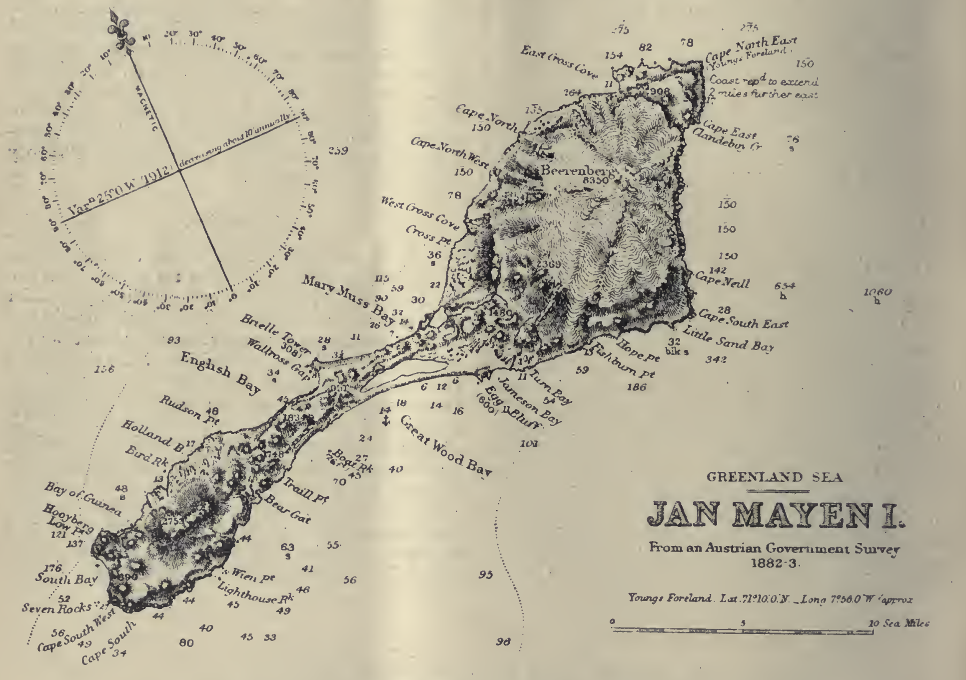

FIG. 1.—Reproduced, by permission of the Hydrographer, from an inset on British Admiralty Chart No. 2751.

season also made it advisable immediately to attack the hitherto unclimbed Beerenberg. To make the ascent direct from sea-level seemed hardly practicable, and an advance camp was, therefore, established at 2700 ft. on the highest of the frontal moraines. Unfortunately, Brown was not well enough to go farther, and the size of the party was thus reduced to three. Starting on August 11 about 11 a.m., for there had been some rain during the night, we trudged for some hours up a gently sloping and but little-crevassed ice-slope to a nunatak at a height of 5600 ft. The real climb now began. Mercanton went first, Lethbridge second, with myself as last man. Two thousand feet of interesting snow- and ice-work brought us finally to the bergschrund not far below the ridge, and after a little delay it was safely negotiated. A stiff climb up a steep snow-wall then brought us to the ridge, and we suddenly found ourselves standing on the rim of a great crater. This was an unexpected and exciting development. The crater was about half-a-mile in diameter, and from 500 to 800 ft. deep. At its northern edge one of the later eruptions had burst the rim and formed a gateway of which the highest part of the mountain is now the western pillar. Since that distant period, however, the crater has become filled with ice, and a much-crevassed glacier now breaks away to the north in a series of striking icefalls, finally reaching the sea (so Mercanton afterwards informed me) as the Weyprecht Glacier. To complete the ascent by following a snow-arête to the actual summit was not long of accomplishment, and gave us a further opportunity of appreciating Mercanton's mountaineering skill. That the summit, deep-covered in rime as it is, has solid rock not far below is certain; scoriaceous lava was collected 50 ft. away. Observations on the summit occupied some time, and, fortunately, there were bursts of sunshine sufficient to enable photographs to be taken. It was almost 9 p.m., therefore, before we commenced the return, but a brisk pace was kept up, and a distance which had taken eight hours on the ascent was now covered in three.

Apart from the geological observations, which showed that the Beerenberg eruptions had been exclusively lava, quite the most interesting and perplexing feature is the gentle ice-slope extending from 5600 ft. down to the camp at 2700 ft. Viewed from a distance, it has all the appearance of an "ice-cap"; it reminded one very closely of the Hardanger Jökul, for instance. At the time I was inclined to regard it as a new type of piedmont or as an "ice-cap" caused by higher precipitation at intermediate levels. It may be so, but, on the other hand, since returning I have noticed that a similar gentle slope characterises both Mount Vesuvius and Mount Erebus, and it can, therefore, be explained on other grounds. Aneroid observations were taken at regular intervals during the ascent. These give Beerenberg a height of 8090 ft. The Austrian figure arrived at by theodolite observations was 8350 ft. It is not usual to prefer aneroid-to theodolite-determined heights, but as the Austrian triangle was a very bad one I think there may be some justification in this case for adopting a lower figure than that generally accepted.

Whilst the mountain was being climbed, Musters and Bristowe had been working at lower levels. After hurried preliminary collections round the base camp they transferred their quarters to a small tent eight miles farther down the coast. From this point the southerly parts were within reach. Musters records a most interesting visit to Seven Hollander Bay, interesting not only historically, but also botanically in respect of the more luxuriant vegetation in that quarter. When Musters finally left the island he was able to tabulate forty-three species of flowering plants, of which five had not previously been recorded there; in addition, the lower orders have still to be worked out and his ecological observations put together. The collections have an added interest just now, as they arrived at the Cambridge Botany School simultaneously with collections made last summer by Prof. Seward in West Greenland, and by Mr. Walton in Spitsbergen. Bristowe's insects are taking longer to name; meantime he has discovered that the spiders are forms met with in the Scottish Highlands; of the flies, etc., only one is native to Britain; the rest are not yet identified. Seventy per cent. of his specimens are new records for the island.

The successful climb on Beerenberg had revealed a good deal about the geology and glaciology. We realised, however, that on that mountain we were dealing with comparatively recent events in the island's history, and the older chapters, if any, had to be discovered. Lethbridge and the present writer in due course relieved Musters and Bristowe at the tent at the south end. From here we ranged over the more distant and inaccessible parts. Apart from the distances which had to be covered, it was arduous travelling both along the coast and on the scree-covered mountain slopes. As the survey was not absolutely exhaustive, additional data may still come to light; meantime the geological record is somewhat as follows: The oldest rocks are coarse and fine augite tuffs; they are generally covered and hidden by later lavas, but are occasionally seen forming rugged and picturesque cliffs along the coast. The earliest lavas were biotite-trachyte; rocks of this composition are nowhere found at craters still well preserved, but always as old hill features. The other and later distinctive lava type is an olivine-augite-basalt rich in alkalis. This rock is found at all the recent craters and also at many older, half-obliterated centres of eruption. A rock of much the same composition, but varying in details, has a widespread occurrence in the form of sills. The south end of the island consists of the older volcanoes; Beerenberg, at the north end, however, must be one of the latest, and round its foot there are many subsidiary cones—*e.g.* Palffy and Vogt craters, which must also be of comparatively recent date. These are exclusively lava craters. One of the very latest, however, is an ash cone—Egg Bluff; it has

a further interest because on the summit there are a few short irregular cracks from which hot steam still issues. Under certain atmospheric conditions these cracks "smoke" quite obviously and this phenomenon was possibly the "eruption" reported by Scoresby in 1818. Scoresby's account is unfortunately written with considerable hesitation. "Smoke" on Egg Bluff scarcely satisfies his description, however. It seems more probable that an ash eruption actually took place at the foot of the western side of Vogt (Scoresby's Esk) crater, possibly in the same spot where the only other authentic eruption, that of 1732, was observed by the whaler, J. J. Laab. Beerenberg itself has never been observed in activity. There is no evidence of when the first eruptions took place; they may even be post-glacial.

Photo] *[W. S. Bristowe*

FIG. 2.—Beerenberg from the south.

As regards glaciology, Prof. Mercanton has supplied me with a brief summary. Glaciers are confined to Beerenberg. Four elements are distinguished: (*a*) the glacier which issues from Beerenberg crater; (*b*) a "collerette glaciaire," continuous in its middle portion, covering the north and north-east parts of the mountain; (*c*) an independent system on the eastern flanks; (*d*) a great "collerette" covering the flanks from north round through west and south to east-south-east. (Part of the latter has already been referred to as the ice-cap feature.) The examination of these different elements shows decreasing glaciation, but whether recent or ancient has not yet been discovered. The rate of movement recorded shows the same order of things as on similar decreasing glaciers in Switzerland. More exact figures, however, will be available when the ground is re-visited.

By the beginning of September it was obvious that the work was now practically complete. Winter weather had already set in, but we were told that we might still make a fair passage. We left the island in *Polarfront* on September 3. *Isfuglen*, however, was remaining another fourteen days in order to bring home the men working at the erection of the wireless station. This they soon completed, and the first message had already reached Norway when we made the coastal waters on September 9. Engineer Ekerold has therefore put up a weather station in a spot where it will be of real value—in the "blind corner" whence no weather warnings had previously been available. He did so

Photo] *[W. S. Bristowe*

FIG. 3.—Mountains at south end of Jan Mayen.

under the most difficult and unsuitable conditions. The work involved the unloading of delicate machines from small boats on an unprotected surf-ridden coast, the overcoming of the difficulties of transport to the site selected, and finally the raising of the masts in adverse wind conditions, and fixing them in frozen ground. Ekerold is now sending daily weather reports to Norway. With the assistance of these it is hoped that it will be possible to forecast the arrival of the northerly and north-westerly gales which come down so suddenly all along the Scandinavian coast, and thus to warn the Norwegian coastal shipping, which has suffered so heavily in the past from the unexpected gales from that "blind corner."

Obituary.

SIR GERMAN SIMS WOODHEAD, K.B.E.

WE regret to record the death of Sir German Sims Woodhead, professor of pathology in the University of Cambridge, which occurred suddenly on December 29. At the commencement of the war Prof. Woodhead was mobilised and became a colonel in the R.A.M.C. (T.), and was for some time head of a camp in Tipperary. He afterwards was appointed inspector of laboratories in the military hospitals in the United Kingdom, a post which involved perpetual travelling and discomfort, the strain of which no doubt conduced to the signs of serious over-work from which of late he suffered. In 1919 he was created K.B.E. in recognition of his valuable war work.

Born in 1855, Woodhead was educated at Huddersfield College, whence he entered the medical faculty of the University of Edinburgh, graduating in 1878. He then spent some time on the Continent, studying in Berlin and Vienna. In 1887 he was appointed superintendent of the research laboratories of the Royal College of Physicians, Edinburgh, resigning this post in 1890 on his appointment as director of the conjoint laboratories of the Royal Colleges of Physicians and Surgeons in London, which he held until his election in 1899 to the chair of pathology in the University of Cambridge in succession to the late Prof. Kanthack. Here it was largely due to his initiative and energy that the new medical school buildings were erected, including the memorial museum to Sir George Humphry.

Woodhead's activities were manifold and untiring; he was a strong supporter of the temperance movement, and was president of both the British Medical Temperance Association and the British Temperance League. He was an hon. LL.D. of Birmingham and Toronto Universities, fellow of Trinity Hall, Cambridge, hon. fellow of the Henry Phipps Institute, Philadelphia, member of the Executive Committee of the Imperial Cancer Research Fund and of the Scottish Universities Committee, and past-president of the Royal Physical Society, Edin. (1878), and of the Royal Microscopical Society (1913–16). It can scarcely be doubted that, had he attempted less, his output of original work in his own special department would have been greater.

Woodhead published in 1883 "Practical Pathology," which reached a fourth edition in 1910; in 1885, "Pathological Mycology" (with Hare); and in 1891, "Bacteria and their Products." He was founder of, and for many years conducted, the *Journal of Pathology and Bacteriology*. In 1894 he published with Dr. Cartwright Wood an investigation on the efficiency of domestic water filters, and during the war devised a method for the chlorination of drinking water. While director of the conjoint laboratories he published a report on diphtheria for the Metropolitan Asylums Board, and devoted much attention to the standardisation of diphtheria antitoxin. Tuberculosis was also a subject to which Woodhead devoted much attention. He drew up a report to the Royal Commission on Tuberculosis in 1895, and was a member of the Royal Commission on Tuberculosis of 1902. Just before the war he devised an apparatus for the continuous record of the temperature of animals, and published the results of investigations obtained by it. Of late the subject of colonies for the tuberculous occupied much of his time, and he was joint author of "Settlements for the Tuberculous." Woodhead was of a genial and kindly disposition, and he will be greatly missed by a large circle of friends and acquaintances.

R. T. H.

PROF. G. S. BRADY, F.R.S.

PROF. GEORGE STEWARDSON BRADY was born in Gateshead on April 18, 1832. His father, Henry Brady, was a surgeon, and he himself was trained for the same career. He was a student of the University of Durham College of Medicine, Newcastle-upon-Tyne, and practised in Sunderland from 1857 to 1906. During the greater part of this period Prof. Brady was also professor of natural history in the University of Durham College of Science, now Armstrong College, Newcastle-upon-Tyne. He began his duties as professor in 1875, and on his retirement in 1906 was elected honorary professor of natural history. In 1906 he went to live in Sheffield, and died there on December 25 last.

Both Prof. Brady and his brother, H. B. Brady, were early interested in natural history, and it is worth remarking that during the time Prof. Brady was studying medicine Tuffen West was an apprentice to his father. All three afterwards attained distinction, Tuffen West as a naturalist artist, H. B. Brady as an eminent authority on Foraminifera, and Prof. Brady for his work on Crustacea, especially on Entomostraca.

Prof. Brady became a member of the Tyneside Naturalists' Field Club in 1849, not long after its inception as a branch of the Natural History Society. He was president in 1871 and again in 1892–93, and he contributed many papers to the Transactions of the Natural History Society. His early papers dealt with algæ and other plant groups, but it was not long before he determined to devote himself to Crustacea and especially to Copepoda and Ostracoda. This work was his hobby, and he devoted his spare time to gathering and to examining his own collections and collections sent to him. The results have been published in a long series of papers, and these brought him into intimate relationship with other workers in the same field here and abroad. But he advanced into a place of prominence when he described the *Challenger* collections of Copepoda and Ostracoda. His reputation was further enhanced when his work on the free and semi-parasitic Copepoda of the British Islands was published by the Ray Society. With the late

Canon Norman he published a monograph of the Ostracoda of the North Atlantic and North-western Europe, and also a catalogue of the Crustacea of Northumberland and Durham.

Prof. Brady's scientific work was done at home. Although he restricted his publications mainly to the results of his examination of Entomostraca from collections made in this and other countries—notably Australia and South Africa—his characteristically neat preparations show that he had interests in all groups which came into the field of his microscope. He was a pioneer in marine dredging, and took an active part in the Northumberland excursions of the early 'sixties, and in the 'nineties he was as keen as before.

It was a pleasure to know Prof. Brady, to be his friend, to watch him work and hear him talk on men and things, on politics and related subjects, and those who had not this privilege will find from his addresses to the Tyneside Naturalists' Club that he gave a critical and well-thought-out consideration to the important questions which arose during his long life and that he had decided opinions and was fearless in expressing them. A. M.

Notes.

We are particularly glad to see the names of Prof. C. S. Sherrington and Prof. W. A. Herdman in the list of New Year honours. Prof. Sherrington, who has been appointed a Knight Grand Cross of the Order of the British Empire (G.B.E.), is the president of the Royal Society, and is to be president of the British Association for the meeting to be held in Hull in September next; and Prof. Herdman, who has received the honour of knighthood, vacated the presidential chair at the Edinburgh meeting last year. The two leading British scientific organisations are thus most appropriately represented in the honours list. Other honours included in the list are:—*Knighthoods:* Prof. G. E. Cory, professor of chemistry, Rhodes University College, Grahamstown; Dr. G. S. Buchanan, Senior Medical Officer Ministry of Health; and Dr. J. H. Parsons, F.R.S. *K.C.I.E.:* Sir John Biles, professor of naval architecture, University of Glasgow. *C.M.G.:* Dr. R. T. Paton, Director-General of Public Health and President of the Board of Health, New South Wales.

This week we begin the publication of a Calendar of Industrial Pioneers, which is intended to supplement the Calendar of Scientific Pioneers which appeared in our columns last year. It is not necessary here to point out the close association that exists between scientific discovery and industrial progress. The two are inseparable. Problems of communication, transport, mining, agriculture, and manufacture depend for their solution on the co-operation of the laboratory and the works. We believe, therefore, that our readers will welcome the series of biographical notes which will recall the great engineers, inventors, manufacturers, and captains of industry who, by the application of the discoveries of the pioneers of science, have extended existing industries, created new ones, or in some other way contributed to the advancement of civilisation.

A conference which commenced on December 12 last was held by permission of the Government at the Ministry of Health, at which delegates from the Health Committee of the League of Nations discussed the international standardisation of therapeutic serums and the sero-diagnosis of syphilis. Prof. Madsen, of Denmark, presided, and Austria, Belgium, France, Germany, Italy, Japan, Poland, Switzerland, Great Britain, and the British Ministry of Health, the War Office, and the Medical Research Council were represented, and the business was conducted by sub-committees. As regards diphtheria and tetanus antitoxins, it was considered both possible and desirable that international units should be fixed for these serums, and a scheme of work to establish them was drawn up. As regards anti-meningococcic, anti-pneumococcic, and anti-dysentery serums, various criticisms were made of the present technique for standardising these, and a scheme of new investigations to obtain more uniformity was adopted. As regards the sero-diagnosis of syphilis, a scheme for comparing the results obtained by the Wassermann reaction with those of other methods was drawn up. An official luncheon was given by the Government to the delegates and guests, at which Sir Alfred Mond presided. It is understood that the conference will meet again in six months' time, probably at the Pasteur Institute, Paris, to report progress and to make further recommendations.

The *Times* of December 24 published a telegram from Delhi announcing that Mrs. Aidie, who is the widow of the late Lt.-Col. Aidie, I.M.S., has discovered a parasite in the salivary glands of the bed-bug, which is probably a stage of the *Leishmania Donovani* parasite of kala-azar. If this important discovery is confirmed it will furnish the final proof of the truth of the theory of Sir Leonard Rogers that the common bed-bug is the carrier of the infection. The human stage of the parasite was first described by Sir William Leishman in 1903, and was found independently by Lt.-Col. Donovan, I.M.S., while in 1904 Rogers cultivated the organism *in vitro* and discovered the flagellate stage of the parasite. In the following year he recorded experiments showing that sterility and a neutral or slightly acid medium, such as he found in the stomach of bed-bugs, were most suitable for this development, while the plan he had advised as early as 1897, of moving healthy coolies out of infected into new lines only a few hundred yards away, had proved so successful in eradicating the disease from tea estates that the infecting agent was not likely to be a flying one, and he pointed out that infection through the ubiquitous bed-bug would explain all the known facts. Major Patton, I.M.S., in Madras next obtained the development of the flagellate stage of the parasite in the

guts of bed-bugs, and certain forms believed to be a post-flagellate stage have since been described by Cornwall, Knowles, and others, but the ultimate development and exact mode of infection have hitherto eluded all workers. Mrs. Aidie has worked for a long time at the Pasteur Institute in Shillong with Major Knowles, I.M.S., so there is every reason to hope that the recent announcement will soon be confirmed. Whether it will help much in dealing with the disease is open to doubt, for long ago Dr. Dodds Price carried out Rogers's suggestion to try to destroy bed-bugs in infected coolie huts in Assam, but without much success, while such very good results in dealing with kala-azar by the tartar emetic treatment are now being obtained in Assam that a vigorous campaign on those lines may be expected practically to stamp out the disease within a few years.

THE following have been elected officers of the third International Congress of the History of Medicine to be held in London on July 17–22 next:—*President of Honour:* Sir Norman Moore, Bart. *President:* Dr. Charles Singer. *Vice-Presidents:* Sir D'Arcy Power and the presidents of the first two congresses, Dr. Tricot-Royer, of Antwerp, and Drs. Jeanselme and Menetrier, of Paris. *Treasurer:* Mr. W. G. Spencer. *General Secretary:* Dr. J. D. Rolleston.

H.S.H. PRINCE ALBERT OF MONACO and Prof. G. O. Sars, of Christiania, were elected foreign members of the Zoological Society of London at its monthly meeting on December 21. The secretary reported that there had been 221 additions to the society's menagerie during November, 104 by presentation, 66 deposited, 5 received in exchange, 44 by purchase, and 2 by birth. The gifts included four lions born in India, presented by the Jam Sahib of Nawanagar. The number of visitors to the gardens during November was nearly seven thousand fewer than during the corresponding month of 1920.

THE annual meeting of the British Medical Association will be held in the University buildings at Glasgow on July 21–28 next. The first three days of the meeting will be taken up by the annual representative meeting, and in the evening of July 25 the new president, Sir William Macewen, will deliver his presidential address. The remaining three days of the meeting will be devoted to scientific and clinical work. Papers and discussions are being arranged for the morning sessions and clinical and laboratory demonstrations for the afternoons. The scientific proceedings of the meeting will be distributed among nineteen sections, each dealing with a particular branch of medicine. In the evening of July 28 a popular lecture will be delivered by Prof. J. Graham Kerr.

AT the next ordinary scientific meeting of the Chemical Society, to be held on January 19, at 8 p.m., Prof. Arthur Smithells will give an account of Langmuir's theory of atomic structure, and will exhibit models. In connection with Sir Ernest Rutherford's lecture on "Artificial Disintegration of Elements," to be given before the Chemical Society on Thursday, February 9, at 8 p.m., it has been decided that visitors will be admitted by ticket only. Fellows of the society will not need tickets for themselves, but those desiring to bring visitors should apply for tickets to the Assistant Secretary, Chemical Society, Burlington House, W.1, not later than January 28. No fellow will be allowed more than two tickets. The lecture will be delivered in the lecture hall of the Institution of Mechanical Engineers, Storey's Gate, S.W.1.

AN exhibition of industrial heating apparatus, to be held in April of this year, is being organised by the Office Central de Chauffe Rationnelle, Paris, under the patronage of the Société d'Encouragement à l'Industrie Nationale and the Société des Ingénieurs Civils de France. The exhibition will comprise apparatus and material connected with "la conservation et la récupération" of heat, and it will be divided into two sections, one including refractory materials, insulators, etc., and the other apparatus and plant, such as economisers, heat-recovery plants, etc. Every facility will be given for experimental demonstrations of exhibits. Further information may be obtained from M. L'Ingénieur Directeur de l'Office Central de Chauffe Rationnelle, 5 Rue Michel-Ange, Paris, XVI. We are informed that the director will be glad to receive applications to exhibit from British manufacturers.

AT a meeting of the Royal Statistical Society on December 20, Mr. E. A. Rusher read a paper dealing with the statistics of industrial morbidity in Great Britain. From a review of investigations on this subject for the past one hundred years, he concludes that (1) age has the greatest influence upon the rate of sickness, and next to this, occupation; (2) occupation has more influence than has either locality or density of population, but the influence of the latter cannot generally be statistically dissociated from that due to occupation; (3) there are no trustworthy statistics in this country of morbidity among female lives; (4) no statistics exist of the sickness experienced by the community at large corresponding to those for mortality published by the Registrar-General. Mr. Rusher advocated a systematic attempt to investigate the data now available through the operations of approved societies under the National Insurance Acts in order to obtain some measure of occupational incidence of sickness analysed into classes of disease.

COL. T. C. HODSON writes in amplification of our condensed report of his remarks in the discussion which took place at the Royal Anthropological Institute on Prof. Elliot Smith's paper on "The Mound-Builders of Dunstable" (see NATURE of December 15 last, p. 512) to point out in reference to the distinct forms of disposal of the dead associated with the mounds, viz. (1) burial of a woman and child in a flexed position and (2) cremation, that in India many living races have two—in one case four—different modes of disposing of the dead, varying according to (*a*) cause of death and (*b*) social status of the dead. Col. Hodson also points out that one of the elemental features of Jhum cultivation in Assam is the use of logs of burnt

trees as retaining walls to hold up the soil and keep in the moisture, and that Mr. Mills's reference to ignorance of the proper ceremonial as a reason alleged for not adopting terrace cultivation throws an interesting light upon the possibilities of the negative aspect of the evidence with regard to this method of cultivation.

In an elaborate paper published in the Journal of the Royal Institute of British Architects (third series, vol. 28, No. 3, October, 1921) Mr. Jay Hambridge supplies "Further Evidence for Dynamic Symmetry in Ancient Architecture." The paper gives a careful series of measurements of the Parthenon and other Greek temples which are of permanent value. The writer remarks: "The temple at Aegina is older than the Parthenon, older than the Zeus building at Olympia; therefore the finding of a persistent dynamic theme in the structure which is simply a variation of the themes at Bassæ, Olympia, and Athens suggests that symmetry schemes had some sort of ritual significance. And this is borne out by the record from India. About the time of the erection of the Greek temples of the best period, if not somewhat earlier, there existed in India specific rules for sacrificial altar construction. These have survived as the Sulvasutra, or 'rules of the cord,' better, 'rules of the rope.' Some authorities date the Sulvasutra about 800 B.C., others place it at 600, 500, 400, and even 200 B.C. The exact date is immaterial, as the point of importance for us is that these rules describe in detail the construction of the root rectangles which constitute the base of classic Greek proportion."

The year which has just closed will long be remembered for its shortage of rainfall over the British Isles, as well as in many other parts of Europe. At Greenwich Observatory, where records are available for more than a hundred years, there is no previous year since 1815 with so small an amount of rain. In 1921 the total measurement for the twelve months was 12·50 in., which compared with the average 24·41 in. for the hundred years from 1816–1915 is only 51 per cent. of the normal, and compared with the normal for thirty-five years, 1881–1915, in use by the Meteorological Office, viz. 23·50 in., is 53 per cent. of the normal. Compared with the one hundred years' normal, the rainfall in each month was less than the average, but compared with the normal for thirty-five years, January and September had slightly more rain than the average. The month with least rainfall was February, with 0·12 in., followed by July with 0·15 in. In the previous 106 years the year of least rainfall was 1864 with 16·38 in., and this is followed by 1847 with 17·61 in., and 1858 with 17·70 in. The rainfall for the eleven months to the end of November was 68 per cent. of the average in England and Wales, 94 per cent. in Scotland, and 86 per cent. in Ireland. At Tenterden, as representative of Kent, the rainfall for the eleven months to the end of November was 49 per cent. of the average; at Arundel, as representative of Sussex, 53 per cent., and at Oxford 59 per cent. Notwithstanding the wild and unsettled character of the weather at the close of the year droughty conditions continued in the south and south-east of England.

The annual report of the Gresham's School, Holt, Natural History Society for 1921 includes a useful list of the flowering plants found in the neighbourhood of Holt, Norfolk, the work of the botanical section, and a preliminary list of the Hemiptera–Heteroptera of the same district, compiled by the entomological section.

In the *Quarterly Journal of Microscopical Science* (vol. 65, part 4), Prof. Champy and Mr. H. M. Carleton discuss the shape of the nucleus and the various mechanical causes, such as surface tension and the pressure of cytoplasmic inclusions, by which it is determined. They come to the conclusion that the amitotic division which occurs in certain highly specialised nuclei results from the attainment by the nucleus of a degree of differentiation that is incompatible with mitosis.

To the few known cases of flagellate protozoa with trichocysts another has been added by the observations of Dr. W. Conrad, who has found trichocysts in *Reckertia sagittifera*, n.g., n.sp., a colourless Chloromoradine found in an aquarium in the Botanic Garden in Brussels (Bull. Acad. Roy. de Belgique, Classe des Sciences, 1920, No. 11). The organism is about 50 microns in length, and has two flagella, one directed anteriorly and the other posteriorly. In addition to swimming by means of the flagella, the organism can creep by means of blunt pseudopodia, about six in number, which serve also for the capture of food, such as bacteria, flagellates, and algal zoospores. A layer of slender, rod-like trichocysts in the ectoplasm gives this region a fine and regular striation. Trichocysts are not present in the pseudopodia. Close to the insertion of the flagella are two lateral contractile vacuoles which contract alternately and discharge their contents into a median apical vacuole. Food vacuoles, similar in their reaction to neutral red to those of Paramecium, are present in the endoplasm. The nucleus is of the vesicular type, and divides by karyokinesis; cell division is, as usual in flagellates, longitudinal.

The story of Lord Howe Island as told by Mr. Allan R. McCulloch in the *Australian Museum Magazine* (vol. 1, No. 2) is a sad one for the naturalist. Situated three hundred miles to the east of Australia, it was uninhabited by man when discovered in 1788, and, having no indigenous mammals or reptiles, was the home of a vast and interesting bird population which, ignorant of the murderous ways of man, knew not how to protect itself from his ravages. One species, *Notornis alba*, unable to fly, quickly became extinct, and, except for one skin in the Vienna Museum and a few stray notes in journals, nothing is known of this interesting bird. The island is a dependency of New South Wales, and in 1879 was declared a reserve in the hope that what then remained of its fauna would be preserved. Success seemed to have rewarded this excellent measure,

but unfortunately rats were accidentally introduced into the island, and the birds' paradise of two years ago has been reduced to a veritable wilderness beyond all hope of recovery. Mr. McCulloch's account of this tragedy is accompanied by excellent photographs and an interesting description of the natural history of the island, with valuable notes on some of the more interesting birds—magpies, woodhens, and mutton-birds.

IN the *Journal of the Federated Malay States Museums* (vol. 10, part 3, June 1921), Major J. C. Moulton publishes the first of a series of articles on Malaysian butterflies, designed to supplement or correct the information of this region given in Seitz's "Macrolepidoptera of the World." The author defines a true Malaysian sub-region as distinct from a wider area, in which a non-Malaysian element is evident, though not necessarily predominant, and defines it as between lat. 10° N., and 10° S., and long. 95° E. and 120° E., thus including the Malay Peninsula, Borneo, Sumatra, and Java, with its adjacent islands. Thirteen new forms and combinations are described. Major Moulton continues the innovations introduced into his earlier papers of printing the sub-specific names in less prominent type than the generic and specific names, and of retaining the author's name for a species even when followed by a sub-specific name. Both courses have since received the approval of the British Association Committee on Zoological Nomenclature. Valuable notes on variations and geographical distribution are given, accompanied by useful keys for the discrimination of species, sub-species, and forms. We may specially note the distinction drawn by the author between "sub-species" and "forms"—the former as geographical races inhabiting separate areas, and the latter as well-defined forms occurring together over a wide range of country.

THE difficult question of the drainage of the Vale of Pewsey, a district now so well known to the aviators of Upavon, is dealt with by Mr. W. D. Varney in the Proceedings of the Geologists' Association, vol. 37, p. 189, 1921. The vale seems to have been excavated originally along the Pewsey anticline of Cretaceous rocks, which provided a line of weakness, by a river flowing eastward from the Cotswolds and escaping southward by the present gap of the Avon, the river that passes through Salisbury to the sea at Christchurch. This stream was beheaded during the growth of the Severn valley, when the other Avon of the district, which flows through Bristol, was working its head backwards and capturing in addition some of the head-waters of the Kennet and the Thames. Mr. Varney's sketch-maps indicate also the recession of the southern coastline and the formation of the Isle of Wight.

IN a lengthy and most instructive article in the *Geographical Review* for October last on the distribution of population Mr. M. Aurousseau directs attention to the fact that three kinds of maps which at present do not exist are much wanted and could be compiled by the geographical survey of countries. The earth-material map would show the following features: Areas of deep drift soils, areas of residual soils, hydrographical information, fuel deposits, and the location and nature of metallic ores and other economic deposits. The power map should show the distribution of the different power resources—wood, wind, water, coal, oil, etc. Finally, the lowlands map would be a topographical map so coloured that the lowlands, even when of small areas as in the case of intermontane deposits, would stand out prominently. Mr. Aurousseau also points out that in taking stock of the world's resources we require to know the expansion ratio of every land—that is to say, the ratio of the extent to which a given area is occupied to the extent to which it may be occupied. He sketches the nature of the geographical survey required in order that this ratio may be obtained.

AN interesting paper on Greek and Roman engineering instruments, read before the Newcomen Society on December 15 last by Mr. R. C. Skyring Walters, illustrates the uses of historical research applied to science. Such research, the product of co-operation between classical scholars and men of science, was also exemplified at a joint meeting of the Textile Institute with the Manchester and District Branch of the Classical Association and Literary and Philosophical Society last November, and it cannot fail to be of great usefulness. In his paper Mr. Walters quotes the description by Vitruvius of the use of the *dioptra, chorabates,* and water levels in surveying by the Greeks and Romans up to about 100 A.D., and he gives sectional drawings showing reconstructions of these instruments, of which no complete example remains. The *groma*, an arrangement of two crossed arms at right angles with suspended plumb lines at the ends, used for setting out straight lines and lines at right angles, is also shown. In the case of the *dioptra* the advanced stage of development in constructive detail which was reached at the time of Hero of Alexandria, is remarkable. The conclusion is that there are many striking points of similarity, not only in the instruments, but also in the methods employed 2000 years ago, with those of the present day.

WE have received an advance copy of a Carnegie Research Memoir published by the Iron and Steel Institute on the constitution of chromium steels by Mr. T. F. Russell. During recent years industrial applications of iron-carbon-chromium alloys have increased, and a paper on this subject, therefore, is welcome. It must be confessed, however, that the present one does not do much to advance our knowledge of chromium steels. The author has confined himself to an examination of a very restricted area of the iron-carbon-chromium ternary system, in which the carbon does not exceed 1 per cent., while the limit of chromium is 12 per cent. It would have been better if he had taken into consideration in the first instance the equilibrium conditions observed in the binary systems iron-carbon, chromium-carbon, and iron-chromium. Without this a scientific interpretation

of the effects observed in the ternary system is impossible. It follows, therefore, that many of the data obtained are as yet purely empirical.

WE learn from the *Times* of December 27 that Major Klein is at work on a three-colour printing process in which the chief innovation is in the taking of the colour records. Instead of the usual light-filters attached to the camera he illuminates the object with light of the desired colour obtained by the well-known method of cutting off with opaque screens the light not wanted in a spectrum produced by suitable spectroscopic apparatus. It seems that he proposes to try the effect of reducing the width of the utilised portions of the spectrum so as to get a nearer approach to monochromatic light, and also the division of the spectrum into more than three parts for four or five, etc., colour processes.

IN the December issue of the Journal of the Society of Chemical Industry Dr. G. C. Clayton contributes an interesting summary of the effect of the war on the heavy chemical industry. The Leblanc soda industry is stated to be obsolete, and many of the by-products formerly obtained by it have now to be prepared by other methods. One of the main products, caustic soda, is now made either from ammonia-soda carbonate or by electrolysis. The two chief electrolytic processes operated in this country are the mercury process, by the Castner-Kellner Co., and the Gibbs diaphragm process, by the United Alkali Co. In the manufacture of chlorine the Weldon and Deacon processes have been displaced by the electrolytic methods. Electrolytic chlorine is produced by the Castner-Kellner, Gibbs, and Hargreaves cells, and is often liquefied. Chlorates are now made only by electrolysis of chlorides.

M. GOMBERG and C. C. Buchler describe in the August number of the Journal of the American Chemical Society the preparation of benzyl ethers of carbohydrates. Glucose, sucrose, dextrin, starch, and cellulose are readily benzylated, and some of the products may be of technical importance from their colloidal and plastic characters.

Our Astronomical Column.

THE EINSTEIN TOWER.—The *Observatory* for December contains an illustrated article on this tower, which has just been erected in the grounds of the Potsdam Astrophysical Observatory. It contains a vertical telescope of 50 cm. aperture and $14\frac{1}{2}$ metres aperture, fed by a cœlostat. There are two spectrographs, one with a plane-grating of $12\frac{1}{2}$ cm. aperture, the other with two large prisms giving a dispersion of two angstroms to 1 mm. The instrument will be chiefly employed to investigate the presence or absence of the Einstein shift, but it is available for general astrophysical work. It is in charge of Dr. E. Freundlich, under the general control of Prof. Einstein, who has now an appointment at Potsdam. Dr. Freundlich hopes to observe next year's eclipse from Christmas Island, with A. Kohlschütter and Dr. Voûte.

CHANGES IN THE CRAB NEBULA.—One of the very useful researches to which the great American telescopes have been applied is the study of changes in the nebulæ, by comparison of photographs taken at intervals of a few years. The changes have been in many cases unexpectedly large, and imply either relative nearness to the solar system or very high internal velocities.

Mr. Lampland had already reported some changes in the Crab Nebula deduced from seventeen photographs taken with the Lowell 40-inch reflector during a period of eight years. Mr. John C. Duncan gives in Proc. Nat. Acad. Sci., June, 1921, the results of a comparison of two photographs taken with the 60-inch reflector at Mount Wilson at an interval of eleven and a half years (1909 and 1921).

Twelve condensations were selected near the outer contour of the nebula, at tolerably equal intervals. Thirteen comparison stars were chosen, one near the centre of the nebula, the others fairly near the selected condensations. The results may be summed up thus: (1) the motions of the condensations are on the average quite three times as great as those of the stars; (2) while the star-motions are at random as regards direction, those of the condensations are systematically outward from the centre, being greatest at the ends of the long axis of the nebula, where they amount to $2''$ in eleven and a half years, implying a linear speed of 25 km./sec. at an assumed distance of one hundred light-years. There is some (not very certain) evidence of a counter-clockwise rotation of the nebula. The mean motion of all the nebular condensations in eleven and a half years is $+0{\cdot}10''$ in R.A., $+0{\cdot}435''$ in Decl., referred to the mean of the stars.

THE ASTROGRAPHIC CATALOGUE.—The publication of this great work was considerably in arrear even before the war, which, naturally, did not tend to improve the situation. It is satisfactory to note that volumes are now appearing in rapid succession.

Mr. H. B. Curlewis, director of Perth Observatory, West Australia, has catalogued the whole of zone $-35°$, the numbers of stars in each quadrant being 6879, 24,753, 22,139, 19,277. The paucity in the first quadrant is explained by its proximity to the South Galactic Pole. The magnitudes are given by letters, A denoting 8·5, B 9·0, and so on; the scale used is that of Chapman and Melotte, and differs from that used in earlier Perth volumes.

Mr. T. P. Bhaskaran has produced vol. 4 of the Hyderabad section, which catalogues the whole of zone $-20°$, the number of stars being 79,590. This volume completes the zone originally allotted to Hyderabad, about half the plates of which had been taken and measured before the death of Mr. Pocock in 1918. The work has been completed on the lines laid down by him. Standard co-ordinates of all stars contained in the Algiers Astr. Gesells. Catalogue are given at the end of the volume.

Señor Leon Herrero, director of San Fernando Observatory, has produced the first half of the catalogue for zone $-3°$ (R.A. 0h. to 12h.). It contains 58,387 stars, and differs from most of the catalogues in containing X_0, Y_0 co-ordinates for all stars, in addition to the measured x, y.

Agriculture at the British Association.

As was to be expected in an important agricultural district such as Edinburgh, the meetings of the Agricultural Section created a good deal of interest, and were well attended throughout the whole of the meeting.

One or two departures from the usual routine have to be noted. Dr. E. J. Russell, of Rothamsted, delivered a popular address to farmers on "Science and Crop Production" on the day before the formal work of the section began. There was a large attendance from the district, including many representative farmers, and the address was much appreciated. A report of Dr. Russell's address has already appeared in NATURE of September 22, p. 116. The second change was that the presidential address, instead of being read at the opening meeting, was circulated amongst the members. At the meeting on Monday, September 12, the president, Mr. C. S. Orwin, gave an abstract of his address, which was followed by a most useful discussion.

The number of papers offered to the committee was almost embarrassingly large; they were grouped, so far as possible, according to subject. On the opening day they dealt mostly with soil problems. Dr. Winifred E. Brenchley spoke on "The Effect of Long-continued Manuring of Grassland," and described the results of experiments which had been carried out at Rothamsted on permanent meadow-land for a period of sixty-six years—long enough to allow a true estimate to be made of the effect of the different fertilisers apart from the influences of season. The effects of complete manuring, one-sided manuring, no manure, and of lime were considered in detail. Dr. W. G. Smith discussed "Methods of Grassland Analyses," and described the results obtained from plots laid down with various grass mixtures in 1914. The plots were analysed annually, and figures were given showing the composition of the plots now as compared with what was laid down.

Dr. W. G. Smith and Dr. A. Lauder gave the results of a soil survey which had been carried out in the Lothians. More than 100 square miles have been surveyed and the vegetation recorded on 6-in. survey maps. Definite relations have been established between the types of vegetation and the productivity of the holdings, and simple methods of improving the grass were described. Dr. Lauder directed attention to the relation between the amount of organic matter and the lime requirement of the soil—a connection which had been noticed by other workers. Mr. M. M. Monie gave an account of a photographic survey of soils which he had carried out in the west of Scotland. His paper was illustrated with an excellent series of lantern-slides, and the method he proposes, while of limited use by itself, should have a useful place in soil-survey work.

Prof. Hendrick dealt with "The Absorption and Retention of Manurial Substances by Granitic Soils." These soils are free from carbonate of lime, have a slightly acid reaction, and a high lime requirement. Notwithstanding these conditions, it was found that, even in very heavy dressings, ammonia was almost completely fixed and an equivalent quantity of nitrates recovered in the drainage. The phosphate was also completely retained. The potash was less firmly held, and in the later periods of the experiment the retention was very slight.

Mr. H. J. Page and Mr. H. G. Thornton contributed an important paper on "The Rapid Fluctuations in Bacterial Numbers and Nitrate Content of Field Soil and their Interrelation."

On Friday the papers dealt largely with dairying problems. Prof. R. A. Berry dealt with the important commercial question of "The Production and Utilisation of Whey." He showed that on a moderate estimate the amount of whey produced annually is worth 337,000*l*. He emphasised the great loss involved under the present methods of disposal, where large quantities are allowed to run to waste, and discussed the possibility of new methods of utilisation. In addition to pig-feeding, the possibility of preparing milk-sugar and whey powders was considered.

Prof. R. H. Leitch described the recent work he had carried out with starters in cheese-making, as well as experiments in the manufacture of rennet, methods of standardising rennet extracts, and some new developments in butter-making. Dr. W. Taylor and Mr. A. D. Husband contributed a note on "The Varying Rates of Secretion of Milk on its Percentage Composition." They come to the conclusion that the interrelationship of volume and composition may be summarised thus:—The percentages of protein, fat, and ash vary inversely, and the percentage of lactose varies directly as the daily volume of milk secreted. Two papers were contributed by Dr. Tocher, one dealing with "The Statistical Analyses of Scottish Milk Records," and another dealing with "The Methods of Determining the Significant Differences of Yield of Milk."

Prof. Hendrick described "A New Scheme for the Determination of Unexhausted Manurial Values," and dealt in particular with the question of cumulative fertility. Dr. Tocher gave the results of experiments on "The Citric Solubility of Manurial Phosphates," and concludes that citric solubility is a worthless test from the agricultural point of view. The only practical tests are:—(1) The total phosphatic content, (2) the degree of fineness of grinding, and (3) freedom from substances of an injurious character to plants.

Mr. J. Alan Murray described some recent experimental work which he had carried out on "The Composition of Ensilage." Mr. Murray dealt with the loss involved in the making of ensilage, and considered that it was a fallacy that farmers can save money by dispensing with root crops and substituting ensilage in the rations of farm animals. He considered that it was not possible to reduce the allowance of concentrated food by substituting ensilage for roots. In the discussion which followed some exception was taken to Mr. Murray's estimates as to the cost of producing ensilage.

The meeting on Monday was devoted to economic questions, and began with the discussion on the president's address, to which reference has already been made. Lord Bledisloe followed with a paper on "Wheat as the Basis of Britain's Food-Supply in Time of War." He pointed out the advantages of potatoes, supplemented by pig-meat, over wheat. Great Britain is self-contained in its potato requirements and an exporter, while under normal conditions she imports four-fifths of her wheat requirements from abroad. The normal production of wheat is preponderantly in the eastern counties of Great Britain (ten counties out of eighty-six provide more than half the total output), while potatoes are grown in every part of the kingdom. Many farmers are wholly unfamiliar with wheat production, and have neither the implements nor the buildings necessary for its production and storage, but every farmer, gardener, and allotment-holder knows how to grow potatoes. Then again, the wheat crop may be wholly lost for human requirements through bad weather or incendiarism. Potatoes, though subject to disease (which can be minimised by spraying), are less vulnerable, as the edible tuber is beneath the ground. Potatoes provide an

immense quantity of starchy food, far exceeding wheat in output per acre, and the crop can be obtained in shorter time and harvested at different periods of spring, summer, and autumn. Potatoes are, however, relatively deficient in fat and protein, but these can be supplied, by way of supplement, by pig-meat. The production of pigs in war-time should, therefore, be encouraged, and not discouraged as during the late war; their capacity for rapid reproduction, large families, high percentage of fat-yield, and great variety of food products render them invaluable meat-providers in a national emergency. Grazing varieties deserve special encouragement. Another reason for the encouragement of potato-growing lies in the large areas of permanent and temporary pasture, valuable storehouses of accumulated fertility, which can be utilised in time of war when fertilisers are bound to be scarce; no crop thrives better in newly-turned pasture than potatoes. Potato-flour is also useful, for it can be converted into wholesome and palatable bread, scones, and cakes, while surplus or unsuitable potatoes can be utilised both as stock food and as the source of motor spirit, commercial starch, etc. The home production of breadstuffs in the form of potatoes will reduce to a minimum the costs and risks of marine transport, and their production in every part of the kingdom for local needs will largely reduce the strain on internal transport.

In the discussion which followed some doubt was expressed as to whether it would be wise to rely so exclusively on one crop as a source of food, especially in view of the danger of the total failure of the crop by disease.

Sir Henry Rew communicated a paper on "Agricultural Statistics: Their Collection and Use" (Journal of the Ministry of Agriculture, vol. 28, p. 636, 1921); Mr. A. W. Ashby dealt with "Standards of Production in Agriculture," and Mr. Pryse Howell with "Economic Surveys of Agriculture in Wales."

On Tuesday the papers contributed dealt mostly with nutrition problems. Dr. W. E. Elliot and Mr. Arthur Crichton contributed a paper describing a series of feeding and metabolic experiments which had been conducted on pigs with the object of determining the cause of a disease variously known as "rheumatism," "cramp," or "rickets." They conclude from the results of their experiments that the condition is produced in animals deprived of access to earth or other mixtures of minerals, and fed only on grains and certain other concentrates commonly used in pig-feeding. The inorganic constituents in these feeding-stuffs do not correspond with the requirements of the growing pig, for there is a marked deficiency of calcium and an excess of acid radicles. If the mineral matter of a ration composed of these feeding-stuffs be adjusted to the requirements of the animal by a mixture of salts compounded to correct the deficiences the disease does not occur. The addition of fat soluble A or of water soluble C to a ration that produces the condition does not prevent the onset of the symptoms. Mr. John Golding exhibited photographs of a litter of pigs from a sow which was fed on a diet deficient in vitamins; they all suffered from serious malformation of the hindquarters. In the discussion which followed exception was taken to the conclusions arrived at by Dr. Elliot and Mr. Crichton. and it was considered by some speakers that it had not been proved that the disease in question was solely due to a deficiency in mineral matter in the ration.

Dr. J. B. Orr then gave an account of "The Application of an Indirect Method of Calorimetry to the Ruminant," and described the apparatus as adapted for experiments with goats.

Major C. C. Hirst gave a paper on "The Genetics of Egg-production in Poultry." Major Hirst described the results of five years' experimental breeding on Mendelian lines, and showed that the first year's egg-production of a hen depends on the combined action of at least seven main genetic factors. The economic significance of the results was discussed in detail, and the effects of the old methods of grading by winter and annual records were pointed out. The new system of grading production has a double value to the practical breeder, because the descriptive somatic gradings, being based on the genetic factors concerned, give a line also to the breeding value of the bird, for the extreme grades tend to breed true. The adoption of this grading system for laying competitions would lead to rapid progress in poultry-breeding, and be of educational value to poultry-keepers in general, for the winning birds would breed winners with more frequency than they do now.

Miss Dorothy J. Jackson described an investigation which she had carried out in the genus Sitones with the object of investigating which species were injurious to leguminous crops in Britain; the life-history of these species has also been determined. No satisfactory method of control is at present known. In the case of the species which breed on clover control would be extremely difficult on account of their prolonged period of egg-laying, but this difficulty would not apply to the species which breed upon peas and beans. Laboratory experiments on infection with the various fungus spores of *Botrytis bassiana* (*Balsamo*), Montagne, have proved successful, death invariably occurring in from nine to thirteenth days.

In a paper by Miss M. S. G. Breeze "The Degeneration in Anthers of Potato" was discussed. Two definite types of degeneration have been observed:—(1) Where the pollen-grains are formed, but degenerate at various stages of development, and (2) in which the pollen mother-cells are apparently normal, but no reduction division takes place. The question of the inheritance of degenerate condition of anthers was also discussed.

In addition to the formal meetings a visit was paid to the Station for Research in Animal Breeding, where a demonstration on the wools of primitive breeds of sheep was given by Dr. F. A. E. Crew. Dr. R. Stewart MacDougall had an interesting exhibit of insects injurious to stock, while in the library of the Agricultural Department there was an exhibition of early works dealing with agriculture and kindred subjects.

On the Friday afternoon the new Plant-Breeding Station at East Craigs, Corstorphine, was inspected. The party was received by Dr. C. M. Douglas, of Auchlochan, chairman of the committee, and Mr. Drummond described the work of the station. Afterwards the farm of Mr. John Cowper at Gogar Mains was visited.

On the Saturday a whole-day excursion took place to typical farms in East Lothian. The concluding visits were to the well-known farms of East Barns and Barneyhill, where the party was received by Sir Harry and Lady Hope.

If a word of criticism may be indulged in, attention might be directed to the fact that few of the readers of papers seriously tried to confine themselves to the time allotted to them in the programme or made a real endeavour to prepare an abstract of their work suitable for presentation to the meeting. In this way the amount of time available for discussion was much too short. The number of papers accepted was probably rather large, but much time would have been saved had some of the readers appreciated the fact that the time at their disposal was necessarily very limited.

A. LAUDER.

The Megalithic Monuments of Malta.

AT a meeting of the Royal Anthropological Institute held on November 15 last Miss M. A. Murray gave an account of her recent excavations in Malta. The excavations were carried out with the consent and kind help of Prof. Zammit. Three sites were explored, all three being in the south-east of the island. The first excavation was of a mound called Santa Sfia, near the village of Hal Far; this proved to be a megalithic site re-used later, and yielded no result. The second excavation was at Santa Maria tal Bakkari, about half a mile away. Here the remains of a double edifice, locally supposed to be two churches, were found. But various indications, amongst others a torba floor, suggest that the building was pre-Christian, and the form and position of many of the stones show that it was originally a megalithic structure. The supposed dedication of the double building to Santa Maria and Santa Katerina may indicate that the shrine was dedicated to two goddesses, and may therefore throw some light on the early deities of Malta. The name of St. Mary is too universal to be any guide, but as St. Katherine has taken the place of a goddess of beacons and lighthouses, we may have here a sanctuary of that divinity. The position of the shrine lends itself to this conjecture, as it stands on high ground in a direct line with a tiny creek, now unused, but sufficiently large for the small fishing-boats of Neolithic times. The name Tal Bakkari is probably connected with the Arabic Fagr, "dawn, daybreak"; the name "St. Mary (or the goddess) of the daybreak" would be appropriate for a shrine built on a hill, from which the open sea due eastward across the Bay of Marsa Scirocco is clearly visible. The first rays of the rising sun strike directly on the shrine.

The third excavation was at Borg en Nadur, close to St. George's Bay. A group of megaliths have always been a well-known feature of the site; this group consists of two dolmenic structures and a building which now appears to be a semi-circular apse, like the apses at Tarxien and the other Maltese temples. In the short time that could be devoted to this excavation it was possible only to prove that the building extended over a wide area, and may possibly be a double temple like those already known. Behind the uncovered apse and on a level with its highest stones is a field, terraced up to its present height in the usual way by a wall of stones. The axis of the "temple" runs directly into this field, and it is very probable that the whole building remains intact hidden under the soil, as was the case at Tarxien. Excavations in the field in which the uncovered apse stands showed a megalithic building extending more than a hundred feet northward from the apse, and a broken bætyl was found *in situ*. Time did not permit of more than a cursory examination of this portion of the site, and it is still uncertain how far or in what way this building is connected with the apse. South-eastward from the apse is another dolmenic structure built into the wall of the field, and adjoining it in the field behind is an apse filled in and covered with stones, but retaining the characteristic semi-circular form. Excavations on the site will be continued next year.

In the course of the discussion which followed the paper Sir Arthur Evans said that, taking the megalithic monuments in Malta as a whole, it was clear that they belonged to a western Mediterranean province which included Sardinia, the Balearics, and possibly the African side. In the Bronze age the evidence was clear; the implements fitted on to the Spanish group. In Spain are found small segmented beads of faience which were a stage in similar forms found in Scotland and parts of England, and began in Egypt with the XVIIIth Dynasty, and appeared in Crete at about the same time. Possibly they were diffused by the Cretans. Although the segmented beads had not been found in Malta, an imitation, associated with them in Spain, had been found there, and it was probable that the segmented beads would also be found. The Neolithic ornament showed a regular progression, starting from Hagia Kim, but it appeared at so advanced a stage that it could not have originated there, and was, possibly, to be derived from Egypt. A vase from Kamares showed strong affinities with a vase from the Neolithic chambers of Malta. The deduction was that the later stage of this culture in Malta came down to about 1600 B.C.

Mr. Peake referred to the rapid development which had taken place in our knowledge of the prehistory of Malta. In 1913 nothing was known of the Bronze age, but the knowledge of an independent type of pottery had now been developed. The evidence pointed to 1800 B.C. as a possible date for Hal Tarxien. The culture was identical with that found all over the megalithic area. The pottery, for instance, was common to Taranto, Spain, Brittany, Guernsey, Arran, Scandinavia, and also Algiers. The only locality outside the megalithic area in which it occurred was Sicily, where, however, a double spiral stone occurred, similar to one from Hal Tarxien, showing that it belonged to the same order. In connection with his suggestion that this culture came from the East, it was interesting to note that Prof. Zammit had also suggested a connection between Malta and the Persian Gulf.

Graft-Hybrids.

AMONG the departures in procedure which marked the Edinburgh meeting of the British Association was the prominence given to a botanic lecture which aimed at a scientific, but non-academic, account by Prof. Weiss of "Graft-Hybrids." Grafting had been a horticultural practice from very ancient times, and was said to date from that of the Phœnicians, and was certainly practised by the Romans, who believed that the stock exercised considerable influence over the scion.

The question of the production of hybrids by grafting first came to the notice of scientific observers in connection with the *Bizzaria orange*, raised in Florence in 1664, and described in the second volume of the Philosophical Transactions of the Royal Society of London. In this case an orange grafted on a lemon stock bore a large variety of fruits, some resembling oranges, some lemons, while others were intermediate in shape and colour. The most curious combination appeared to consist of an orange shell with lemon pulp. This latter feature was significant in relation to the "graft-hybrids" afterwards obtained, probably the best known and most frequently discussed of which is *Cytisus Adami*, obtained in Paris in 1825 by grafting a small purple-flowered *Cytisus purpureus* on an ordinary yellow laburnum. The graft did not succeed, but from a small bud arising close to the place of insertion a branch was produced inter-

mediate in character between scion and stock. The graft-hybrid is generally sterile, and therefore is usually kept going by grafting. On the rare occasions when seed is set it produces normal yellow laburnum.

In the account given by McFarlane in the Transactions of the Royal Society of Edinburgh for 1892 the suggestion was made that the distribution of characters is such that the graft-hybrid consists apparently of a core of laburnum wrapped in a skin of Cytisus. This supposition has been confirmed in the more recent production of graft-hybrids by grafting common nightshade on the stem of a tomato and *vice versa*. In all cases the stock would appear to furnish the core and the scion the epidermal tissues of the "hybrid."

This simple explanation, however, does not appear to cover fully the graft-hybrids between medlar and hawthorn obtained by Prof. Daniel, in one case of which, at any rate, tissues were present which differed from those of either parent.

In general, therefore, graft-hybrids represent shoots produced adventitiously near the point of grafting and containing representation of the tissues of both plants, in many cases, *e.g. Cytisus Adami*, so arranged that the external tissues resembled those of the scion and the internal those of the stock. There were, however, instances—*e.g.* quince and pear—in which an intimate mixture of the characters of stock and scion appeared in the graft-hybrid which *may* have been accompanied by vegetative union of the cells, but no clear case of this cytological process had yet been established.

The whole phenomenon of graft-hybrids requires further investigation, particularly in relation to cases in which the "hybrid" is said to occur on the scion far removed from the point of grafting, which may turn out to be instances of bud variation, possibly with reversion.

Fauna of African Lakes.

DR. W. A. CUNNINGTON, leader of the third Tanganyika Expedition (1904–5), has contributed to the Proceedings of the Zoological Society of London (December, 1920), a comparative study of the fauna of the African lakes—Tanganyika, Victoria Nyanza, Nyasa, Albert Nyanza, Edward Nyanza, and Kivu, with special reference to the first-named. The results of recent investigation, admirably summarised in this memoir, lend no support to the view put forward in 1898 by Mr. J. E. S. Moore, leader of the first and second expeditions, that Tanganyika represents an old Jurassic sea, and that its fauna is of relict nature. Of the six lakes, Tanganyika has by far the most remarkable fauna—of its 402 species 293 are endemic, and 57 of its 168 genera are peculiar to its waters; of the 146 species of fishes 121 are endemic, and a notable feature is the high degree of specialisation of the Cichlidæ, the lake presenting the richest known assemblage of this family. There is a large molluscan fauna, and of the species of gastropods more than two-thirds—the halolimnic forms (Moore)—exhibit a marine-like appearance, and these are, without exception, endemic. Noteworthy is the absence of Cladocera, and the relative scarcity of rotifers, which may be correlated with the salinity of the water, and especially with the excess of magnesium salts. Dr. Cunnington points out that geological investigation indicates that the extensive beds of sandstone and conglomerate which occur in the lake regions were probably formed under fresh-water and terrestrial conditions, that the trough in which Tanganyika lies was apparently not formed until middle tertiary times, and that the lake had no outlet until recent geological times. Experts have not accepted Moore's comparison of shells from the lake with marine fossil shells of Jurassic age, or his views as to the primitive nature of the halolimnic gastropods. The endemic species in the fauna of Tanganyika are now held to be specialised rather than primitive. The conclusion reached is that Tanganyika owes its remarkable fauna to a long period of isolation, sufficiently extensive for the inhabitants of the lake to assume the characters of species and even genera distinct from those of the neighbouring parts of the continent.

University and Educational Intelligence.

IN connection with the Conference of Educational Associations which is being held at University College, Gower Street, W.C.1, the annual general meeting of the Education Guild of Great Britain and Ireland took place on December 30. The president of the guild, Sir Wilmot Herringham, delivered the presidential address, taking university education as his topic. He commented on the lack of interest in university education shown by the majority of people, and emphasised the value of the inclusion of natural sciences in a general education as a training in inductive reasoning. There is also material gain by the training of a number of skilled practitioners in chemistry, physics, engineering, medicine, etc., but the most important function of the university is discovery. Taking examples from medical science only, gas gangrene, surgical shock, and the effects of poison gas were mentioned as specific problems arising during the war in which investigations were undertaken with success in university laboratories. Another interesting fact mentioned was that between 1838 and 1851 out of every million people born in Great Britain 500,000 died before the age of forty-five years; in 1881 that age had risen to forty-eight; and by 1891 it was fifty-two years—an increase in average life due, at any rate in part, to research and discovery accomplished by men of science working in the laboratories of our universities.

ACCORDING to the December issue of the *School Science Review*, the representatives of the Science Masters' Association met the Joint Standing Committee of the Headmasters' Conference and Association of Preparatory Schools in June last and made certain suggestions for the teaching of science in preparatory schools. As a result it was recommended that (1) in the Common Entrance Examination the scope of the geography paper be widened, that some of the questions in the mathematical paper should test a boy's knowledge of practical mathematics, and that in the composition paper candidates should have an opportunity of showing a knowledge of natural science; (2) candidates for scholarships should be given an opportunity of answering questions on natural science in a *viva voce* examination as well as in the general paper; and (3) at least one, and if possible two, periods a week should be devoted in preparatory schools to science. The council of the Association of Preparatory Schools was at first unwilling to adopt any of these proposals, but after they had been approved by the Headmasters' Conference the council of the Association of Preparatory Schools agreed to them by 12 votes to 3. When this decision is carried into effect boys in preparatory schools will have an opportunity of gaining some knowledge of science at an age when all natural phenomena are of absorbing interest to them—a privilege boys in secondary schools have enjoyed for some time.

Calendar of Industrial Pioneers.

January 1, 1890. Horatio Allen died.—A pioneer among American locomotive engineers, Allen visited the Stockton and Darlington Railway in 1828, and afterwards conveyed to the United States the locomotive "The Stourbridge Lion." In 1871–73 he served as president of the American Society of Civil Engineers.

January 2, 1875. Eber Brock Ward died.—In 1864 Ward erected an experimental steel plant at Wyandotte, Michigan, where the first Bessemer steel made in the United States was produced. He was among the earliest to erect a works laboratory and to employ a works chemist. He also did important work in connection with water and rail transport.

January 3, 1795. Josiah Wedgwood died.—The friend of Watt, Erasmus Darwin, and Priestley, and a fellow of the Royal Society, Wedgwood by his experiments added several new species of pottery ware to English manufacture and turned the current of importation of the finer earthenwares into that of exportation. "He was the most successful and original potter the world has ever seen."

January 5, 1887. Sir Francis Bolton died.—The inventor of a system of signalling for the Army and Navy, Bolton was widely known for his electrical work, and he took a prominent part in founding the Society of Telegraph Engineers and Electricians, now the Institution of Electrical Engineers.

January 6, 1911. Sir John Aird died.—For sixty years Aird was engaged on important engineering schemes, his crowning work being the famous Assuan dam on the Nile built for the Egyptian Government in 1898–1902. The dam is 2200 yards long, it has 180 sluice-gates, and contains more than 1,000,000 tons of masonry.

January 6, 1886. Alhémar Jean Claude Barré de Saint Venant died.—Engaged for many years on practical work as an *ingénieur des ponts et chaussées,* Saint Venant was an eminent elastician, contributing much to the study of the strength of structures.

January 8, 1861. Samuel Clegg died.—A pupil of Dalton, Clegg while an apprentice at Birmingham witnessed Murdoch's experiments on gas lighting and himself became one of the pioneers of the gas industry.

January 8, 1825. Eli Whitney died.—Holding a pre-eminent place among the early inventors of America, Whitney, though originally a blacksmith, graduated at Yale, and while a private tutor in 1793 produced his cotton gin. This enabled one man to clean a thousand pounds of cotton a day instead of five or six pounds. In twelve years the export of cotton rose from 189,000 lb. to 4,000,000 lb. per annum.

January 9, 1843. William Hedley died.—With Trevithick, Stephenson, Blenkinsop, and Hackworth, Hedley was one of the pioneers of the locomotive. In 1813 at Wylam Colliery, near Newcastle, he built the "Puffing Billy," the first practical and efficient locomotive ever constructed. This engine is now in the Science Museum at South Kensington.

January 9, 1862. Samuel Colt died.—In 1835, at the age of twenty, Colt patented his repeating pistol or revolver, for the manufacture of which he built a factory where automatic and semi-automatic machinery was used.

January 11, 1877. Alfred Smee died.—Surgeon to the Bank of England, Smee was best known for his work on electricity. The Smee battery was devised by him, and he did pioneering work in electric metallurgy, including the art of electrotyping. E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, December 19, 1921.—M. Georges Lemoine in the chair.—The president announced the death of M. Henry Parenty, correspondant for the section of mechanics.—E. **Borel**: The theory of games of chance and integral equations with symmetrical nucleus.—P. **Termier** and L. **Joleaud**: Summary of our knowledge of the Suzette layer (exact age, constitution, and extent): the question of its origin. This layer came from the Alps in the Aquitanian period, and is exclusively formed of Triassic elements.—C. **Richet**: The psychological unity of time.—G. **Gouy**: The surface tension of electrified electrolytes. In a recent communication M. Félix Michaud has proved that the surface tension of an electrolyte is not changed by the electrification of the surface, and hence raises an objection to the ionic hypothesis, since the ions, by accumulating at the electrified surface, should modify the capillary forces. The author states that it is not the ionic theory that is at fault, but the view that the charge is constituted by the ions accumulated at the surface. The latter hypothesis is inadmissible, since a small charge does not diminish the osmotic pressure in the interior of the electrolyte nor the total number of ions per unit of volume.—G. **Friedel** and L. **Royer**: Mixtures of anisotropic liquids and the identity of the stratified liquids of Grandjean with liquids of the azoxyphenetol type.—R. **Lagrange**: The absolute differential calculus.—J. **Wolff**: The series $\sum \frac{A_k}{z-a_k}$.—A. **Denjoy**: Quasi-analytical functions with real variable.—E. **Delassus**: Closed articulated chains.—H. **Abraham** and R. **Planiol**: An astronomical chronograph of precision. An auxiliary electrical clock, controlled by an astronomical clock, beats tenths and twentieths of a second, and these are marked on a smoked strip by a recording galvanometer; the same instrument records the observed times on the same strip, and an accuracy of 0·01 sec. (or greater if required) is readily attained by a direct reading without a micrometer.—J. P. **Lagrula**: The principle and scheme of a recording chronograph with geometrical synchronisation.—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the third quarter of 1921. Ninety days' observations are summarised in three tables, showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—E. **Esclangon**: The relativity of time.—J. **Le Roux**: Interference and reflection in a mobile system.—J. **Chappuis** and M. **Hubert-Desprez**: Electrolysis by stray currents. Two metal plates forming the electrodes were placed in sawdust or earth moistened with an electrolyte contained in a wooden box. The course of the corrosion was followed continuously by X-ray photographs.—M. **Taffin**: The measurement of double refraction in tempered glass.—M. **Siegbahn**: New measurements of precision in the X-ray spectrum. A description of an improved instrument of a type described in 1918, capable of measuring a wave-length with an accuracy of 0·002 per cent.—A. **Sellerio**: Analogies and differences between the total galvanomagnetic effect and its correlative thermomagnetic effect.—J. **Duclaux**: The mechanism of continuous-light radiation.—B. **Bogitch**: The expansions of some refractory materials at high temperatures. Refractory bricks of silica, bauxite, clay, chromite, and magnesia and their expansions were studied up to 1500° C. Bauxite bricks had the lowest coefficient of expansion. Silica gave an irregular curve and lost

its strength at about 600° C. The highest expansions were shown by magnesia and chromite bricks, and hence these are suitable only for furnaces in continuous work.—A. **Charriou**: The lime carried down by ferric hydroxide precipitates. To reduce the amount of lime adsorbed by precipitated ferric hydroxide to a minimum the calcium chloride solution should be very dilute and the ammonia added only just sufficient to precipitate the iron.—M. **Grandmougin**: The halogen derivatives of indigo.—J. B. **Senderens** and J. **Aboulenc**: The catalytic hydrogenation of the polyphenols in the wet way. Hydroquinone, resorcinol, pyrocatechol, pyrogallol, and phloroglucinol can be reduced in the presence of nickel by hydrogen under pressure (30 to 50 atmospheres) at temperatures between 115° C. and 145° C. At higher temperatures secondary reactions take place; thus resorcinol at 120° C. gives resorcite (1 : 3-*cyclo*hexanediol), but at 180° C. some *cyclo*-hexanol is produced.—M. **Lespieau**: Derivatives of erythritol-acetylene,

$$CH_2(OH)\cdot CH(OH)\cdot C\equiv C\cdot CH(OH)\cdot CH_2(OH).$$

—R. **Fosse**: The synthesis of a nitrogenous principle of plants, hydrocyanic acid, by the oxidation of ammonia and carbohydrates, glycerol, or formaldehyde. Potassium (or calcium) permanganate, in presence of silver nitrate, with ammonia and various organic bodies, gives cyanides as one of the oxidation products. —C. **Jacob** and M. **Removille**: A fall of meteorites in Cochin China.—P. **Viennot**: The southern edge of the north Pyrenean Flysch, between the valleys of Aspe and Saison.—J. **Yung**: The Hercynian tectonic of the Vosges.—P. **Corbin**: New observations on the eastern border of the mountains of Lans.—Mlle. J. **Pfender**: The presence of pebbles not of local origin at Alon (Var).—E. **de Martonne**: Erosion platforms of the metalliferous mountains of Banat.—Mlle. Yvonne Boisse **de Black**: Researches on the Mindelian alluvium in the high valley of Cère and on the plateau of Lacapelle-Barrez (Cantal).—P. **Loisel** and R. **Castelnau**: The radio-activity of the waters from Mont-Dore. Determinations of the radio-activity of the water from twelve hot springs are given; the gases from eight springs have also been examined. The gases contain a higher proportion of radium emanation than the waters, and this proportion varies with the spring and with the date of collection.—A. **Boutaric**: The nocturnal radiation at Mont Blanc.—G. **Arnaud**: The affinities of the Erysiphæ and the Paradiopsidæ.—L. **Blaringhem**: Heredity and physiological characters in the hybrids of barley.—G. **André**: The transformations undergone by oranges on keeping. The ripening of oranges by keeping is due to a reduction of acidity, the loss of sugars being relatively small. These changes cannot be wholly due to oxidation, since they are produced in a vacuum. Diastatic action is suggested as possible.—P. **Dangeard**: The evolution of the aleurone grains in castor-oil seed during germination.—M. **Bridel** and Mlle. Marie **Braecke**: The presence of saccharose and aucubine in the seeds of *Melampyrum arvense*. Full details are given of the method of extracting saccharose and the glucoside aucubine from the seeds. Rhinanthine, extracted by Ludwig from the seeds of *Rhinanthus Crista-Galli*, was also stated by Ludwig and Müller to be present in the seeds of *Melampyrum arvense*. The identity of rhinanthine with aucubine has not yet been proved.—H. **Hérissey**: The biochemical synthesis of α-methyl-*d*-mannoside. By the action of the ferment present in germinated lucerne seeds upon *d*-mannose in dilute methyl alcohol solution, α-methyl-*d*-mannoside is formed. Details of method of isolation and proofs of identity are given. —A. **Demolon**: The sulphur-oxidising power of soils. —L. **Mercier**: The larva of *Limnophora aestuum*, a marine Diptera.—A. **Michel**: The interpretation of the profound histological differentiation of the dorsal elytra and cirrus of the Aphroditian Annelids.—J. L. **Lichtenstein**: The determination of egg deposition in *Habrocytus cionicida*.—L. **Roule**: The periodic changes of habitat of the common tunny fish (*Orcynus thynnus*) and their connection with the changes of medium. The migrations of the tunny fish are determined by the temperature and salinity.—L. **Léger** and E. **Hesse**: Microsporidia with spherical spores.—L. **Ravaz** and G. **Vergé**: The germination of the spores of vine mildew. Lime solutions are carbonated too rapidly on exposure to air to exert any toxic action on the mildew spores. Copper-lime mixtures resist the action of rain and dew and preserve their toxic power.—R. **Legroux** and J. **Jimenez**: The factor of growth in cultures of *Leishmania Donovani*.—G. **Bourguignon** and A. **Radovici**: Chronaxy of the sensitive rachidian nerves of the upper limb in man.—E. **Nicolas** and P. **Rinjard**: The vaccination of cattle against bovine plague.

WASHINGTON, D.C.

National Academy of Sciences, Proceedings, vol. 6, No. 11 (November, 1920).—A. **Weinstein**: Homologous genes and linear linkage in *Drosophila virilis*. A long and detailed study with numerous bibliographic references, not lending itself to recapitulation.—F. C. **Hoyt**: The intensities of X-rays of the L-series, III. Critical potentials of the platinum and tungsten lines. A continuation of an earlier work to the classification of some lines that were doubtful.—E. B. **Stouffer**: Semi-variants of a general system of linear homogeneous differential equations.—A. G. **Webster**: Some new methods in interior ballistics. A *résumé* of extended experiments on the principal problem of interior ballistics, namely, to determine the position and velocity of the shot, and the mean temperature and pressure of the gases in the gun. Graphical and analytical methods are used.—C. B. **Bridges**: The mutant crossveinless in *Drosophila melanogaster*. —J. A. **Detlefsen**: Is crossing over a function of distance? The author differs from the conclusion of many students of genetics, and believes that linkage is not a function of distance, that the distance between the two genes may remain fairly constant, and that the crossing over depends upon hereditary factors.—E. E. **Babcock** and J. L. **Collins**: Interspecific hybrids in Crepis. The behaviour of the seven-chromosome Crepis hybrid leads to the belief that there is not such a direct relationship between the two parent species as has been suggested.—C. G. **Abbot**: New observations on the variability of the sun. A discussion of an extended set of observations from July, 1919, to March, 1920, revealing a wide fluctuation in the sun's radiation.—L. P. **Eisenhart**: The permanent gravitational field in the Einstein theory.—G. A. **Linhart**: A simplified method for the statistical interpretation of experimental data.—C. B. **Lipman** and G. A. **Linhart**: A critical study of fertiliser experiments. From a statistical study of fertiliser experiments the authors conclude that no fertiliser experiment as ordinarily conducted is possessed of sufficient practical value to justify the large amount of money, time, and energy involved.

No. 12 (December, 1920).—H. **Shapley**: Preliminary report on pterergates in *Pogomyrmex Californicus*.—J. F. **McClendon**: Hydrogen-ion concentration of the contents of the small intestine. Criticism of the general erroneous impression that the intestinal contents are alkaline.—F. P. **Underhill** and M. **Ringer**: Blood concentration changes in influenza. Both

physiologically and pathologically there is a marked resemblance between influenza and war-gas poisoning, with a marked increase in the concentration of the blood.—E. L. **Nichols** and D. T. **Wilbur**: Luminescence at high temperatures. Announcing the discovery of luminescence at temperatures which are, roughly speaking, above the beginnings of a visible red heat. —S. R. **Detwiler**: Functional regulations in animals with composite spinal cords. The evidence indicates that the factor which is involved in the over-production of motor cells is the stimulus afforded by the connection with the central neurones.—A. S. **King**: Experiments with the tube resistance furnace on the effect of potential difference. The conclusion is that the potential difference acting on the tube is not effective in modifying the spectrum in certain temperature ranges.—J. H. **McDonald**: An application of the porism of four tangents of a twisted cubic.—H. A. **Cheplin** and L. F. **Rettger**: Studies on the transformation of the intestinal flora, with special reference to the implantation of *Bacillus acidophilus*, II. Feeding experiments on man. Attempts to implant *Bacillus bulgaricus* failed, as in the feeding experiments on rats. It appears that *Bacillus acidophilus* milk possesses several advantages over ordinary sour and *Bacillus bulgaricus* milk.—Kilauea Volcano Observatory: A report by the committee of the National Academy of Sciences at the request of the Secretary of Agriculture with reference to desirability of the control of the observatory being assumed by the Weather Bureau.

Official Publications Received.

Legislative Document No. 39: State of New York. Thirty-second Annual Report of the New York State College of Agriculture at Cornell University and of the Agricultural Experiment Station established under the Direction of Cornell University, Ithaca, New York, 1919. Vol. I. Pp. civ+1074+30+8+57 plates. Thirty-third Annual Report, 1920. Transmitted to the Legislature, January 15, 1921. Pp. 79+4. (Ithaca: Cornell University.)

Cornell University: Agricultural Experiment Station. Memoir 34: An Economic Study of Farm Layout. By W. T. Myers. Pp. 383-564. Memoir 35: Some Effects of Potassium Salts on Soils. By R. S. Smith. Pp. 565-606. Memoir 36: Resistance of the Roots of some Fruit Species to Low Temperature. By D. B. Carrick. Pp. 607-662. Memoir 37: A Modified Babcock Method for Determining Fat in Butter. By N. W. Hepburn. Pp. 663-690. (Ithaca: Cornell University.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 113. Special Publication No. 60: A Study of Map Projections in General. By O. S. Adams. 5 cents. Serial No. 121, Special Publication No. 62: Triangulation in Rhode Island. By Earl Church. 30 cents. Serial No. 143, Special Publication No. 67: Latitude Developments Connected with Geodesy and Cartography. By O. S. Adams. 20 cents. Serial No. 146, Special Publication No. 68: Elements of Map Projection, with Applications to Map and Chart Construction. By C. H. Deetz and O. S. Adams. 50 cents. Serial No. 150, Special Publication No. 69: Modern Methods for Measuring the Intensity of Gravity. By C. H. Swick. Pp. 96. 15 cents. Serial No. 155: Results of Observations made at the U.S. Coast and Geodetic Survey Magnetic Observatory, near Tucson, Arizona. By D. L. Hazard. 20 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Water Supply Paper 449: Ground Water in the Meriden Area, Connecticut. By G. A. Waring. 466: Ground Water in the Southington-Granley Area, Connecticut. 468: Records of Water Levels in Wells in Southern Carolina. By F. C. Ebert. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 719: Preliminary Report on Petroleum in Alaska. By G. C. Martin. 50 cents. Bulletin 721: Geology and Petroleum Resources of North-Western Kern County, California. By W. A. English. 10 cents. Bulletin 715-M: Permiam Salt Deposits of the South-Central United States. By N. H. Darton. (Washington: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. 72, No. 8: A Review of the Interrelationships of the Cetacea. By H. Winge. Translated by G. S. Miller, Jr. (Publication 2650.) Pp. ii+97. Vol. 72, No. 11: The Echinoderms as Aberrant Arthropods. By A. H. Clark. (Publication 2653.) Pp. ii+20. (Washington: Smithsonian Institution.)

Canada. Department of Mines: Mines Branch. The Preparation, Transportation, and Combustion of Powdered Coal. By J. Blizard. Pp. 131+3 plates. (Ottawa: Department of Public Printing and Stationery.)

Tide Tables for the Eastern Coasts of Canada for the Year 1922, including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits, and Information on Currents. Issued by the Tidal Current Survey in the Department of the Naval Service of the Dominion of Canada. (Twenty-sixth Year of Issue.) Pp. 68. (Ottawa: Department of Public Printing and Stationery.)

Experiment Station of the Hawaiian Sugar Planters' Association. The Improvement of Plants through Bud Selection. By A. D. Shamel. Pp. iv+28+41 plates. (Honolulu.)

Madras Agricultural Department. Year Book, 1920-21. Pp. vi+123. (Madras: Director of Agriculture.) 10 annas.

Office scientifique et technique des Pêches Maritimes. Notes et Mémoires No. 8: Rapport sur la campagne de Pêche de l'Orvet dans les Eaux tunisiennes. Par Prof. G. Pruvet. Pp. 12+1 map. 3 francs. Notes et Mémoires No. 9: Recherches sur le Régime des Eaux Atlantiques, au large des Côtes de France et sur la Biologie du Thon Blanc ou Germon (Observations faites pendant la seconde croisière de la Tanche, Août et Septembre, 1921). Par Ed. le Danois. Pp. 16+6 plates. 4 francs. (Paris: Ed. Blondel la Rougery.)

Department of the Interior: United States Geological Survey. Professional Paper 121: Helium-bearing Natural Gas. By G. S. Rogers. Pp. 113. (Washington: Government Printing Office.)

Departement van Landbouw, Lijverheid en Handel. "'S Lands Plantentium." (Jardin Botanique de Buitenzorg.) Treubia: Receuil de Travaux Zoologiques, Hydrobiologiques et Oceanographiques. Vol. 1, Livraison 4. Pp. 139-300+plates 8-12. (Buitenzorg.) 4 francs.

The Botanical Society and Exchange Club of the British Isles. (Vol. 6, Part 1.) Report for 1920. By the Secretary, G. C. Druce. Pp. 207. (Oxford: The Secretary, Yardley Lodge.) 10s.

Fourteenth Annual Report (1920-21) presented by the Council to the Court of Governors at a Meeting held in Cardiff on October 28, 1921. Pp. 35. (Cardiff: The Museum.)

Canada. Department of Mines: Mines Branch. Bulletin No. 33: Gas Producer Trials with Alberta Coals. By J. Blizard and E. S. Malloch. (Supplementing Report No. 331.) Pp. 40. (Ottawa: Department of Public Printing and Stationery.)

Department of Scientific and Industrial Research. Building Research Board. Special Report No. 2: Experiments on Floors. An Extract from the Report of the Building Materials Research Committee. Pp. 21. 1s. 3*d*. net. Special Report No. 3: The Stability of Thin Walls. An Extract from the Report of the Building Materials Research Committee. Pp. 13. 6*d*. net. Fuel Research Board. Fuel for Motor Transport. Second Memorandum by the Fuel Research Board. Pp. iv+16. 6*d*. net. (London: H.M. Stationery Office.)

Mines Department: Miners' Lamps Committee. Memorandum No. 4: Record of Research on the Passage of Flame through Perforated Plates and through Tubes of Small Diameter. Pp. 19. 9*d*. net. Memorandum No. 5: Record of Research on the Passage of the Flame of an Explosion from within Miners' Lamps fitted with Chimneys. Pp. 13. 6*d*. net. (London: H.M. Stationery Office.)

Department of Commerce. Scientific Papers of the Bureau of Standards. No. 421: Wave Lengths longer than 5500A in the Arc Spectra of Yttrium, Lanthanum, and Cerium, and the Preparation of Pure and Rare Earth Elements. By C. C. Kiess and others. Pp. 315-352. (Washington: Government Printing Office.) 5 cents.

Union of South Africa. Department of Mines and Industries: Geological Survey. Sheet 52: Johannesburg. (Pretoria: Geological Survey.)

Proceedings of the Royal Irish Academy. Vol. 36, Section A, No. 1: On Polygons to Generate Diagrams of Max. Stress on Girders due to Locomotives and Dead Loads, together with an Extension of Rankine's Conjugate Load Areas to the Design of Masonry Arches. By T. Alexander and J. T. Jackson. Pp. ii+30. (Dublin: Hodges, Figgis & Co.; London: Williams and Norgate.) 1s.

Proceedings of the Geologists' Association. Vol. 33, Part I. Pp. 80+4 plates. (London: E. Stanford, Ltd.) 5s. net.

Agricultural Research Institute, Pusa. Bulletin No. 117: Experiments with Castor Seed conducted at Sabour. By C. S. Taylor. Pp. ii+10. 3 annas. No. 119: The Agricultural Development of Baluchistan. By A. Howard and G. L. C. Howard. Pp. iv+27. 6 annas. No. 122: Pusa 12 and Pusa 4 in the Central Circle of the United Provinces. By B. C. Burt and others. Pp. iv+34. 11 annas. No. 124: Safflower Oil. By A. Howard and J. S. Remington. Pp. ii+14. 4 annas. (Calcutta: Government Printing Office.)

Diary of Societies.

THURSDAY, JANUARY 5.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 11.45 a.m.—R. L. Thompson and others: Discussion: Geography and History in Schools.

ASSOCIATION OF ASSISTANT MASTERS IN SECONDARY SCHOOLS (at London Day Training College), at 2.30.—Prof. T. P. Nunn: The Purposes of Education.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 2.30.—Sir Halford J. Mackinder: Problems of the Pacific.

ROYAL INSTITUTION, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: Electric Oscillations.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 4.—E. N. Fallaize: The Anthropological Institute and the Services it can render to Geographical Students.

CENTRAL ASSOCIATION FOR THE CARE OF THE MENTALLY DEFECTIVE (at University College), at 5.—Dr. G. A. Auden: The Possibility of Co-operation between the School Medical Officer and the Teacher in the Training of Subnormal and Mentally Defective Children.
LONDON HEAD TEACHERS' ASSOCIATION (at University College), at 5.30.—D. J. Collar and T. G. Tibbey: Intelligence Tests in Schools.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Wing-Cmdr. W. D. Beatty: Specialised Aircraft
GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 5.45.—Lord Robert Cecil: Presidential Address.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. S. P. Smith: Single and Three-phase Commutator Motors with Shunt and Series Characteristics.
PHYSICAL SOCIETY AND OPTICAL SOCIETY (at Imperial College of Science and Technology), at 8.—A. A. Campbell Swinton: The Johnsen-Rahbek Electrostatic Telephone and its Predecessors.
ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—B. Whitehouse: Salpingotomy *versus* Salpingectomy in the Treatment of Tubal Gestation.—J. B. Hunter: Short History and Post-mortem Notes of an Interesting Case of Diffuse Carcinoma following Cancer of Cervix.—A. W. Bourne: Hyperthyroidism in Functional Menorrhagia.

FRIDAY, JANUARY 6.

GEOGRAPHICAL ASSOCIATION (at King's College), at 10.20 a.m.—Dr. Fleure: The Co-operation of Historians and Geographers.
GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 3.—Miss L. Winchester: Some Climate Problems of Modern Palestine.—At 4.—Dr. Hogarth: The Hedjaz.
ROYAL GEOGRAPHICAL SOCIETY (Christmas Lectures to Young People) (at Æolian Hall), at 3.30.—Sir Francis Younghusband: Pictures from Mount Everest.
INSTITUTION OF MECHANICAL ENGINEERS (Joint Meeting with the Society of Chemical Industry), at 6.—G. M. Gill: The Co-operation of the Engineer and Chemist in the Control of Plants and Processes.
JUNIOR INSTITUTION OF ENGINEERS, at 8.—A. E. Bingham: Stone and Marble-working Machinery.

SATURDAY, JANUARY 7.

COLLEGE OF PRECEPTORS, at 11.30 a.m.—Prof. J. Adams: Psychoanalysis and its Value and Limitations from the Standpoint of the Practical Teacher.
ROYAL INSTITUTION, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: Electric Waves.
GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—E. Kay Robinson: British Wild Life.

MONDAY, JANUARY 9.

ARISTOTELIAN SOCIETY (at 21 Gower Street, W.C.1), at 8.—Dr. F. C. S. Schiller, C. Joad, and Prof. R. F. A. Hoernlé: Discussion: Mr. Russell's "Analysis of Mind."
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.
SURVEYORS' INSTITUTION, at 8.—W. R. Davidge: Problems of Greater London.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Sir Philip Brocklehurst: Across Wadai.

TUESDAY, JANUARY 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: Wireless Telephony.
MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—C. E. Tilley: Density, Refractivity, and Composition Relations of Some Natural Glasses.—A. Russell: Laurionite and Paralaurionite from Cornwall.—W. A. Richardson: A Simplification of the Rosewal Method of Micro-analysis.
INSTITUTION OF CIVIL ENGINEERS, at 6.—A. W. Rendell: Control of Trains in Relation to Increased Weight and Speed combined with Reduced Headway.—Sir Henry Fowler and H. N. Gresley: Trials in Connection with the Application of the Vacuum-brake for Long Freight Trains.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—Dr. B. T. J. Glover and others: Discussion: Should the Manufacturers Supply Figures indicating the Contrast Grading of Gas-light and Bromide Papers?—A. F. Kitching: Demonstration of Some Effects with Ultra-violet Light.—The General Electric Co., Ltd.: Developments Rendered Possible in Projection Work by the Introduction of the Osram Gas-filled Projector Type Lamp.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. C. Turney: Mosquito Investigation.
RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Prof. A. O. Rankine: The Structure and Dimensions of Molecules.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—J. Whatmough: Rehtia, the Venetic Goddess of Healing.
ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. R. G. Rows: The Application of Modern Methods in the Treatment of Psychoses.

WEDNESDAY, JANUARY 11.

ROYAL SOCIETY OF ARTS (Mann Juvenile Lecture), at 3.—Dr. W. R. Ormandy: Clay: What it is, where it comes from, and what can be done with it.
INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—E. W. Monkhouse: The Economic Aspects of Various Methods of Power-transmission.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—Dr. F. W. Lanchester and R. H. Pearsall: An Investigation of Certain Aspects of the Two-stroke Engine for Automobile Vehicles.

THURSDAY, JANUARY 12.

ROYAL AERONAUTICAL SOCIETY (Juvenile Lecture) (at Royal Society of Arts), at 3.—Major D. C. H. Hume: Boats that Fly.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Exhibition of Cinematograph Films.—P. Torchio, with explanatory notes by Dr. C. C. Garrard: Investigations and Tests on High-tension Switchgear.—F. Gill: Telephone Inventors of To-day.—F. Gill: The Audion.—F. Gill: Electricity in the Home.
OIL AND COLOUR CHEMISTS' ASSOCIATION (at Food Reform Club, 2 Furnival Street, E.C.), at 7.30.—A. H. Keable: Super Centrifugal Force and its Application to the Clarification of Varnish and Dehydration of Oil.
OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Dr. C. J. Peddle: The Manufacture of Optical Glass.—Dr. J. W. French: The Barr and Stroud 100 ft. Self-contained Base Rangefinder.—T. Smith: The Optical Three Apertures Problem.
INSTITUTE OF METALS (London Section) (at Sir John Cass Technical Institute), at 8—Col. N. Belaiew: The Inner Structure of the Crystalline Grain.
HARVEIAN SOCIETY (Annual General Meeting) (at 11 Chandos Street, W.1), at 8.15.—Dr. G. de Bec Turtle: Some Points on Spasm in the Alimentary Tract (Presidential Address).

FRIDAY, JANUARY 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.—J. S. Paraskévopoulos: Jupiter in 1915 and 1916: Rotation Period in Different Latitudes, from Observations at the National Observatory, Athens.—Prof. G. Forbes: Solar Motion from 1922 Radial Velocities.—Major W. J. S. Lockyer: The Use of a Graduated Wedge in Stellar Classification and Parallax Work.

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Classics and Science.

LORD MILNER, in his presidential address to the Classical Association on January 6, made a notable declaration of the unity of educational purpose of classical and scientific studies. He pointed out that to the mind which had received real enlightenment there could be no antagonism between these two great branches of human knowledge. "All modern science had its roots in the classics, and, on the other hand, no man imbued with the spirit of the great classical writers could be lacking in respect for science or fail to recognise its supreme importance to the progress of mankind." Lord Milner went on to say:—

"I wonder what Plato and Aristotle, could they reappear among men to-day, would say to an education that was purely linguistic, even if the literature with which it occupied itself was the best ever known. Looking with wondering eyes on the achievements of science which had transformed the world since their day and given to man command over physical forces such as they had never dreamed of, would they not be seized with an intense desire to probe these marvels to the bottom, to know all about their causes, the methods and the steps by which such great results had been attained? And what would they think of a man who, living in the midst of these achievements, took no interest in them except in so far as they affected his personal convenience and well-being, enabling him to satisfy his wants cheaply, to travel with rapidity and comfort, to communicate in a few minutes with the uttermost ends of the globe, to escape suffering, avert disease, and even postpone the advent of death, and who never felt impelled to go more deeply into the matter and to learn something of the inner nature of the mysterious forces the discovery of which was so rapidly transforming the life of men upon this earth? Any Greek philosopher revisiting the world to-day would condemn such a man as a misfit—a creature unsuited to its environment."

With this conception of the close relationship between classical learning and scientific discovery most scientific workers will be in cordial agreement. The common enemies of both are ignorance, sordid commercialism, and general public indifference to intellectual light, whether it comes from the past or the present. There was a time when this was not so clearly recognised as it is to-day, and when classical scholars placed followers of experimental science among the barbarians. Tradition, method, social distinctions and professional prospects were then all on the side of the classics of Greece and Rome, and the most capable pupils were directed to the study of them and discouraged from devoting attention to modern scientific studies. It was claimed that instruction in classical languages was particularly valuable in developing accuracy, training reasoning powers, improving the memory, and cultivating all the faculties necessary to make the best use of life in any field. Psychologists have, however, destroyed the educational concept upon which this claim is based, and it is no longer believed that the exercise of the mind on one kind of material improves the faculty to deal with other kinds. No subject can therefore be put forward as affording unique general training in mental faculties or powers.

We are glad that Lord Milner did not base his plea for classical studies upon the grounds of the mental discipline secured through concentration upon the letter, but dealt rather with the spirit manifested in the literature and culture of ancient Greece and Rome and its guidance for life to-day. Whatever may have been the true source of Greek thought and discussion, whether intuitive or acquired, our own intellectual culture is unquestionably of Greek origin. While Latin was first taught as a medium of expression, and for use in the needs of life, Greek was studied for the knowledge to be gained through it. We do not hesitate to pay tribute to the brilliant genius of Ionian philosophy, the careful work of Hippocrates and his school, and the richness of the Alexandrian epoch. In the teaching of the Ionian school it is possible to find, as Prof. Gomperz has pointed out, two of the corner-stones of modern chemistry—the existence of elements and the conception of a single fundamental or primordial matter as the source of material diversity. Advanced views relating to the shapes and motions of bodies in the solar system were held at a very early date in Greek

history (though they were afterwards superseded by childish ideas), and the first phase of the history of thought upon organic evolution began with early Greek philosophers in the seventh century before the opening of our era, while its effects on Christian theology and Arabic philosophy were felt for more than two thousand years. Acquaintance with these and other achievements of Greek genius should be part of the intellectual equipment of every educated man, and the science student can find even more to admire in that wonderful age than can the purely literary scholar.

While, however, we hold the philosophers of Greek antiquity in highest honour, it must be confessed that the whole of Greek natural knowledge has little bearing upon the principles, methods, and practice of modern science. Scarcely a scientific work of to-day contains a reference to contributions to the subject by Greek philosophers, and their guesses or observations may be said to be disregarded by scientific discoverers generally. While the mathematician esteems the achievement of Euclid and the investigations of Archimedes, and the physician finds much to admire in the works attributed to Hippocrates, the chemist and experimental biologist are disposed to regard Greek speculation on their respective subjects as fruitless. Indeed, from the point of view of practical chemistry, it would be more reasonable to study Arabic literature than Greek. The creative genius of the early Greeks is undoubted, but its results are negligible in comparison with the work of modern science.

The value of acquaintance with Greek learning is not in the material knowledge itself, but in the spirit which created it. The Greeks possessed to a high degree the spirit of scientific curiosity and the desire to find a natural explanation for the origin and existence of things which is the ground motive of progress in science. The aim of Greek thought was the unification of disconnected knowledge. This laid the foundation of synthetic science, but carried with it the tendency to reduce natural phenomena to a rigid geometrical or logical system. It is possible that the modern science student would be all the better if given a trend in the same direction, as experimental inquiry alone is apt to be narrow and must be specialised. Even neglecting this philosophical aspect of science, the early Greeks manifested supremely the characteristics of true apostles of science. Passionate regard for truth, disinterested research, imagination, acute reasoning, and creative intelligence were the essence of the Greek spirit, and they are elements of the unalterable germ-plasm which transmits the scientific temper throughout the ages. Because inspiration and constructive thought are necessary to the student of natural knowledge, the writings of Greek philosophers cannot be neglected by him without detriment to his intellectual equipment.

It is the human side of Greek thought and action that the science student should know, and the scientific facts themselves are ancillary to it as a means of training. Science as studied in most schools is a spiritless performance and has not that contact with human nature required to make it appeal to most pupils. Attention to the history of great scientific discoveries may perhaps tend to counteract the conception of science as a mere repository of facts and a vocational study. Greek philosophy can usefully take an important place in such a course, but consideration must be given to the most appropriate stage at which to introduce it. It is now generally agreed that there should be no specialisation of studies below the age of about sixteen years, so that up to this stage all students should have formed the same foundations of a general education, including both the literary and the scientific elements. If the preliminary training thus received in classics enabled an average pupil to read original Greek texts by sixteen years of age, the value of this attainment to the student who then proposes to devote himself mainly to science cannot be doubted. As, however, such proficiency is rare, it would appear that the case for the teaching of Greek or Latin holds chiefly for those who propose to continue the study to an advanced stage, and that for students who propose to specialise in other directions preliminary instruction which is necessarily truncated serves no very useful purpose.

A subject of study should be considered as an instrument of service—mentally, morally, and materially—as a working part of the machinery of life. If the preliminary training in classics cannot reach this stage of attainment for science students, then obviously it would be better to absorb the spirit of Greece through translations than to spend time at what must prove a vain study so far as reading original texts with intelligence is concerned. No student who proposes to devote himself to science could hope to render Aristotle into English in the style of the translation now being published by the Clarendon Press under the editorship of Mr. W. D. Ross, or of Sir Arthur Hort's translation of the "Enquiry into Plants" from the Greek of Theophrastus published in the Loeb Classical Library, to mention two instances only. Whatever may be urged as to the value of the study of the classics to science students must refer chiefly to the substance of the best works in these languages, and that can be gained from translations.

Acquaintance with the Greek spirit through such means is much needed in science teaching when the age is reached at which a student can appreciate the systematising aspects of science. Early interest in science comes through wonder and delight in the intrinsic beauty and charm of natural phenomena, and is followed by interest in the use of the forces of Nature by man. With adolescence comes the power of appreciating systems of theoretical completeness and unity, and it is then that attention may usefully be turned to the thoughts of Greek philosophers. Young pupils are very rarely impressed by unifying principles and philosophical speculations whether placed before them in Greek or their own language. Their work in science is thus almost necessarily limited to acquaintance with perceptual phenomena, and conceptual ideas make little appeal to them. Similarly in historical studies striking episodes and dramatic events are more easily intelligible to immature minds than the constitutional or other causes which produce them. Probably a grammatical generalisation is more readily understood than a principle derived from laboratory measurements, and on that account pupils who have been trained to apply scientific method to language may be better prepared to take up the study of science seriously than one in whose mind there is nothing but loose ends. Whether Greek and Latin are essentially the most suitable languages for promoting this sense of law and order, as well as facility in the art of expression, is a matter of opinion. There may on these grounds be a value in preliminary training in classics to students who propose to devote themselves mainly to scientific pursuits, but there is so much in Greek science and philosophy that cannot be understood without acquaintance with natural knowledge that an even stronger plea can be made for training in science for those who intend to give their chief attention to classical studies.

The Hormone Theory of Heredity.

Hormones and Heredity: A Discussion of the Evolution of Adaptations and the Evolution of Species. By Dr. J. T. Cunningham. Pp. xx + 246 + 3 plates. (London: Constable and Co., Ltd., 1921.) 24*s*.

IT would be no exaggeration to say that holes could be picked in any theory of heredity as yet put forward. The problem is one of great difficulty and complexity, and when we think of the enormous number of qualities or "factors" conveyed in the minute space of an ovum, or still more in a single sperm-cell, it seems at first sight impossible to believe that all these qualities are "represented," rather than that the presence of certain of them, which might be called "key-factors," imply the development of numerous others. But, however this may be, the thought suggests itself that perhaps the knowledge we possess of the nature of protoplasmic structure and function is not yet sufficiently advanced to warrant the statement of any theory professing to be adequate. We are, indeed, in some doubt even with respect to certain fundamental facts. As will have been clear to readers of the correspondence in these columns, in which Sir Archdall Reid and others have taken part, the actual meaning of many of the terms used is in dispute.

It may be of use to attempt to express in a few words the main question at issue without using language of uncertain connotation. Suppose, then, that an organism is exposed to a new set of external conditions. Some forces or influences acting upon it are changed, and the effects produced in the organism, which we call its "reactions," are not the same as before. These reactions are, of course, conditioned by the nature of the organism itself, and may or may not be of such a kind as to be of benefit to it in adjustment to the new state of affairs. If they are so, they are sometimes called "adaptations." But this term is apt to suggest to certain minds a species of directing agency, and is best avoided. In any case, the length of life of such an organism will be dependent on its response to the changed conditions. Those organisms with the longer life naturally leave more offspring, which will be more like their parents than like the offspring of parents which have responded less favourably to the change in environment. The first-mentioned offspring will, therefore, respond to this changed environment in the same way as did their parents, and probably some of them, owing to the random shuffling of the material of the germ-cells, more favourably.

It will be seen that we are not justified in speaking of such a case as one of "inheritance of acquired characters." If the response in question were continued in the offspring after the altered environment had returned to its original or some other state, an alteration in the "germ-plasm" might be supposed to have been produced. But some difficulty arises here in respect of cases in which it appears that a change may be persistent for a few generations and that then reversion to the original mode may occur. Are such cases to be regarded as changes brought about in the germ-plasm? We note how difficult investigation is made by the length of time needed for the tests. Many researches are in progress at the present time, and

we may look for much light from them. The conviction seems to be growing that at all events a slow and gradual change in the germ-plasm may be produced by altered conditions, although the main lines of heredity may be determined by ancestral nature.

Many obscure facts have to be taken into account, and it is no wonder that the author of the book before us finds it an easy task to show how unsatisfactory are the various theories of heredity and variation that have been suggested. He therefore puts forward a new one, which appears to have taken its present form on account of the renewed attention attracted to the effect of the chemical products of one organ on the activity of another—on account of the discovery of the mechanism of pancreatic secretion by Starling and the present reviewer in 1902. The hypothesis that every tissue of the body gives off its own specific chemical product, and that this product has its effect to a greater or less degree on all other tissues, was put forward by Brown-Séquard and d'Arsonval as early as 1869, but was thrown somewhat into discredit by the uncritical use of it by the former. Dr. Cunningham gives the credit of the first suggestion to Claude Bernard in 1855, but we regret to have been unable to find the statement referred to. It would be of much interest to have the exact reference.

The hormone theory of heredity may best be given in the words of its propounder: "We have within the gonads numerous gametocytes whose chromosomes contain factors corresponding to the different parts of the soma, and these factors or determinants may be stimulated by waste products circulating in the blood and derived from the parts of the soma corresponding to them" (that is, to the determinants). Thus the effect of chemical products on any particular organ or tissue in the soma is to be supposed to be exercised in the same way on the "determinant" in the germ-cell which afterwards gives rise to such organ in the progeny. For example, the exostosis on the frontal bone of stags, formed as a result of repeated butting, would give off products, not necessarily different in kind from those of bone in general, but in increased amount, and thus stimulate the corresponding factors in the germ-cells.

While it would perhaps be rash to deny the possibility of a process of this kind, the objection might naturally be made that when applied to the inheritance of bodily structures in general, or of changes in them, it argues so enormous a variety of "hormones" as to seem almost incredible. Not only so, but the chemical product of each organ and tissue must act on the germ-plasm in a way which leads to the formation of a tissue like that by which the hormone was formed. In view of the difference between the structure and activity of the germ-plasm and those of the various constituents of the soma, are we justified in supposing that a particular chemical compound will affect both in the same way or even in a similar way? Moreover, waste products would be expected rather to have a retarding than a stimulating influence on similar reactions. But it might be held that the hormones in question are not waste products in the ordinary sense, and that the precise name is immaterial.

The possibility cannot be denied that, however inaccessible to nervous action the germ-plasm may be, it must be affected by chemical agents in the blood. Indeed, Stockard's experiments, to mention a single instance only, show that this is so with alcohol. But in such cases the effect is of a more or less generalised nature on the progeny, and the existence of tissue products of the kind demanded by Dr. Cunningham's theory is not yet demonstrated. As Prof. Swale Vincent has pointed out, it is remarkable how few "internal secretions" have actually been shown to exist as chemical individuals. Although it may savour too much of mysticism, it is open to question whether the original form of Dr. Cunningham's theory, in which "influences" were spoken of, might not be the more cautious and wiser one as yet. The loss of differentiation in the growth of tissues *in vitro*, except in the proximity of another tissue, no doubt indicates some kind of influence by one tissue on another. But the fact that this influence disappears when the new cells wander away into the culture fluid is difficult to reconcile with a chemical product.

Notwithstanding this objection, the theory must be given the credit of introducing functional or physiological considerations into the problem, as does the somewhat similar one of Delage. Most theories seem to be content with the purely structural view of rows of determinants in chromosomes and the shifting about of these. The difficulty in those theories which limit the transmission of hereditary characters to the chromosomes is that these exist as distinct entities only at the time of karyokinesis, while even the nucleus itself is but a part of the cell in functional relation with the whole. Whether the chromosome view is necessarily involved in Mendelian interpretations is subject to doubt, however significant the experimental facts may seem. Bateson appears to be unconvinced, and states that the results of such experiments have not solved the problem of adaptation, while Brachet has obtained evidence that the ovum, when fertilised after removal of the nucleus, can transmit characters of the female parent.

Dr. Cunningham appears to be justified in his complaint that, although his theory was published in 1908, later writers have put forward similar

views without reference to his work. In the book before us he includes a detailed account of his experiments on the origin of somatic sex-characters, and uses these as the main support of his theory. One must admit that explanation on other lines is extraordinarily difficult. The discussion of the origin of the scrotum on pp. 147 and 148 is of much interest, although, no doubt, objection may be taken to the view of its origin as a kind of traumatic hernia.

Space forbids detailed reference to the many other facts of importance brought forward, such as the difference between specific and adaptive characters, the origin of new dominants, the presence of useless characters, continuous and discontinuous variations, and so on. Loeb's "tropism" theories are adversely criticised. The facts and views put forward cannot be neglected by investigators of the problems of heredity, and the book as a whole requires careful consideration. It is of particular value in bringing to notice a theory which was previously known to an inadequate degree, and, although modifications will doubtless need to be made, the various facts and theories contained in the book must not be forgotten in the formation of a complete theory of heredity. Dr. Cunningham's theory has the undoubted merit of suggesting new forms of experiment, and everyone will agree with the opinion expressed on p. 64: "Further light on the sex problem, as in many other problems in biology, can only be obtained by more knowledge of the physical and chemical processes which take place in the chromosomes and in the relation of these structures to the rest of the cell."

W. M. BAYLISS.

Medicinal Chemicals.

Organic Medicinal Chemicals (Synthetic and Natural). By M. Barrowcliff and F. H. Carr. (Industrial Chemistry.) Pp. xiii + 331. (London: Baillière, Tindall, and Cox, 1921.) 15*s.* net.

IN writing this book Messrs. Barrowcliff and Carr had in mind the production of a critical compendium of methods for the manufacture of organic medicinal chemicals, which would be useful to teachers and to those occupied in research work in the industry itself. The idea was to restrict attention to those published processes which seem capable of industrial application and are therefore of first importance when improvements are under consideration.

It may be said at once that for the ends in view the volume leaves little to be desired. The information given is well selected and reasonably complete, though it clearly does not exhaust the authors' knowledge of the subject: the descriptions are clear and easy to follow.

Considerations of space are no doubt responsible for the brevity exhibited in some cases; thus, under pilocarpine there is no reference to the alkaloids which accompany it in jaborandi, though any attempt to make pilocarpine is sure, sooner or later, to bring the operator into contact with *iso*-pilocarpine. The authors have every excuse for not embarking on a critical *résumé* of the tangled chemistry of digitalis by way of introduction to their description of the manufacture of the various products which appear in commerce as active principles of this drug; nevertheless, there can be no question that such a *résumé* would have been useful. It should be added, however, that the authors have only themselves to thank if their readers prove exacting in such matters, because in most cases they have provided excellent summaries of the kind indicated, which serve to emphasise the few cases in which they are lacking.

The subjects dealt with are grouped for the most part according to therapeutical applications—*e.g.* anæsthetics, narcotics, analgesics—though this arrangement is departed from when it is more convenient to group together a series of related substances such as the naturally occurring alkaloids and organo-metallic compounds. As already indicated, little that is essential has been omitted, but it might have been a good plan to refer quite briefly at the end of each section to any particularly promising drugs suggested by recent investigations. Thus, under local anæsthetics, mention might have been made of benzyl alcohol and certain of its homologues and derivatives, since these are already coming into use, at any rate in the United States, as a result of the work of Macht and his collaborators.

A drug which is not referred to, but is of special interest at the present time, is santonin, for the plant from which it is made grows in Soviet Russia, and there also is the only factory producing the drug. The plant is, however, now being grown experimentally in the United States, and a possible new source of supply has been found in India. Santonin is one of the best-known anthelmintics, a group of drugs which merits more attention than has been given to it by British chemists. The British Empire probably possesses among its coloured populations in the tropics more victims of hookworm, to mention only one of this group of parasites, than any other country, with the possible exception of China, and, like China, it is largely dependent on public-spirited citizens

in the United States for the distribution of suitable anthelmintics and the conduct of anti-hookworm campaigns within its borders. Processes for the preparation of these drugs are well-known, and the authors would be rendering a further service to their colleagues if they would add a section on anthelmintics when a new edition of their book is called for.

The volume is well produced, and contains a number of useful diagrams of plant and a good index. The proof-reading has been carefully done, and printers' errors are commendably few.

T. A. H.

Some New Text-books on Radio-telegraphy.

(1) *Wireless Telegraphy and Telephony: An Outline for Electrical Engineers and Others.* By L. B. Turner. Pp. xii + 195 + 24 plates. (Cambridge: At the University Press, 1921.) 20*s*. net.

(2) *Thermionic Tubes in Radio-Telegraphy and Telephony.* By John Scott-Taggart. Pp. xxiii + 424. (London: The Wireless Press, Ltd., n.d.) 25*s*.

(3) *Continuous Wave Wireless Telegraphy.* By Prof. W. H. Eccles. Part 1. Pp. vii + 407. (London: The Wireless Press, Ltd., n.d.) 25*s*. net.

(4) *Principles of Radio-Communication.* By Prof. J. H. Morecroft, assisted by A. Pinto and W. A. Curry. Pp. x + 935. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 45*s*. net.

(1) IT is a pleasure to come across a technical book, like that by Mr. Turner, which has the literary qualities of clearness, life, and continuity. In too many scientific text-books the manner is as cold as the matter is dead and already dissected; the parts are evident, but the whole is left to the constructive imagination of the reader. A book may be crammed with exact information, and yet be so unreadable as to have little value from the point of view of education. Even quite a slight historical framework adds human interest and may guide the student along the course of thought which resulted in discovery, and a text-book in which such a framework exists is therefore much more educative than one which merely states the physical facts, however accurately.

Unfortunately for the average student a sound knowledge of the mathematics of motion is required in the study of the production of high-frequency currents on account of the large number of variables involved, especially when the converter is a thermionic valve or an arc. Again, unfortunately, this branch of mathematics is known, in spite of Newton, by the entirely unilluminating and indeed repellent name of "the differential calculus." "Calculation by differences" does not suggest motion any more than "bits of iron" would suggest a locomotive, and it is doubtful if the would-be engineer realises that in avoiding this unpleasantly named subject as much as possible he is debarring himself from the most interesting and useful branch of mathematics. Could not mathematical teachers make the learning of the laws of motion more interesting than the study of geometry in the same ratio as a kinema is more attractive than a photograph?

In the books under review mathematics are freely used except in (2) Mr. Scott-Taggart's "Thermionic Tubes," which is quite an encyclopædia of types and circuits, but does not enter deeply into exact theory, although the graphical explanations are very useful. Mr. Turner has the happy knack of working his equations so naturally into the text that the deductions which he makes from them are almost self-evident, and although his book contains only 190 pages, there is but little that could be added with advantage to the outline which he has set himself to give. An interesting personal opinion is given on p. 11, where he says he can derive no satisfaction from the usual semi-Hertzian diagram of wave radiation over a conducting surface; but why should Dr. Howe's model, in which an inverted conducting cone with its apex at the transmitter is substituted for the upper atmosphere, be any simpler? It merely evades the question of where the lines go in space, and neglects the fact that aircraft experiments indicate that their directions are probably such as are shown in the Hertzian diagram. The expression of the opinion, however, shows the perfect honesty with which Mr. Turner treats his readers.

The other books are different in scope and style. (3) Dr. Eccles's is a first volume only and is devoted to the theory of electromagnetic induction and conduction on metallic circuits and vacuum tubes; both branches of the subject are treated clearly and in great detail, and a sound basis is laid for a thorough understanding of the technical applications which will presumably form the greater part of his second volume.

(4) Few, if any, books on radio-telegraphy have covered so many details of the subject as Prof. Morecroft's "Principles of Radio-Communication," and there is little connected with the functions of radio-gear which he does not touch upon.

A good deal of original matter is incorporated in the book, and, as the author says in his preface, much on which further experiment may be based. The descriptions of instruments and the theories of their actions are clear, but though the text is, on the whole, quite simply written, the mass of material is somewhat overwhelming, and one cannot help feeling that this is due, at least in part, to the space given to certain sections being out of proportion to their importance. It is a pity that the appearance of the book is marred by the very careless printing of the many half-tone blocks with which it is illustrated.

It is rather remarkable that actual radio-telegraphic transmission from station to station is dismissed in these text-books in a very few pages; in fact, their subject is rather radio-telegraphic instruments than radio-telegraphy. Atmospherics and their elimination, the laws of the transmission of power, the causes of distortion of wave fronts, and the relative telegraphic efficiencies of various methods, are the most important problems in radio-telegraphy to-day, and their solution is incomparably more urgent than that of any question of purely instrumental theory.

Our Bookshelf.

The New Physics. By Dr. A. C. Crehore. Pp. xii + 111. (San Francisco: *Journal of Electricity*, 1920.) 2 dollars.

OBJECTION may be raised against the title of this book, on the grounds that it has been used before, and that it seems to imply an exaggerated sense of the importance of the views therein expressed. The physical dimensions of electric and magnetic quantities are first discussed, and the author, rightly we think, emphasises the importance of retaining the specific inductive capacity, k, and the permeability, μ, in the equations. He supposes that k may be considered as the reciprocal of a velocity, and Maxwell's relation then automatically determines μ as a quantity of the same kind. This gives a single system of units for all quantities in terms of length, mass, and time, electric and magnetic charges appearing as quantities of the same dimensions. Dr. Crehore's next step is far more questionable—he assumes that the dimensions of mass are those of a velocity. We cannot attach much importance to the first of the "two equally forceful reasons" he advances in support of this assumption. His new expression for Planck's constant may be the result merely of a numerical coincidence. His second reason is based on the gravitational equation which he has developed, but this equation has been criticised, and must be considered as still *sub judice*. As a literary production the book cannot be commended, and the habit of stating results "in advance of the narrative" tempts one to suggest that it should be read backwards.

Fermat's Last Theorem: Proofs by Elementary Algebra. By M. Cashmore. Third edition. Pp. 67. (London: G. Bell and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

THE first attempt to prove Fermat's last theorem contained in this edition repeats a fallacy to which attention has already been directed in NATURE, Oct. 30, 1919. On pp. 18, 21, "quantities" t and u are defined, and it is assumed that these quantities are integers, which is not generally the case. In the second attempt there is a fallacy, pp. 34–35, relating to the divisibility of numbers. The pamphlet ends with a version of Barlow's attempt to prove the last theorem, taken from the 1811 edition of his "Theory of Numbers." Barlow's attempted proof contains a well-known fallacy, which need not be pointed out here.

In view of the considerable erroneous literature concerning Fermat's last theorem it may not be out of place to direct attention to two valuable additions to the correct literature which have appeared since the last edition of Mr. Cashmore's book was reviewed in NATURE. They are: (1) Mr. L. J. Mordell's "Three Lectures on Fermat's Last Theorem," and (2) a chapter in vol. 2 of Prof. L. E. Dickson's "History of the Theory of Numbers."

W. E. H. B.

The Physical Properties of Colloidal Solutions. By Prof. E. F. Burton. Second edition. (Monographs on Physics.) Pp. viii + 221. (London: Longmans, Green and Co., 1921.) 12*s.* 6*d.* net.

THE second edition of this work conforms in general to the plan of the first, *i.e.* it gives an account of the properties of suspensoid sols from the point of view of the physicist. The Brownian movement and the electrical phenomena accordingly claim the largest share, while the optical properties of small particles are also treated with unusual fulness. The rather difficult investigations dealing with these matters are summarised with great skill and lucidity. Apart from some omissions—among which the X-ray analysis of colloidal particles, Pauli's work on the effect of radiation, and Ostwald's on the protection of Congo-rubin sols must be mentioned—all important advances made since 1914 have been embodied in the present edition. This applies specially to the gradual breaking down of all "valency rules" in electrolyte coagulation. The book is excellently produced, and will be welcome to all serious students of the subject.

An Introduction to Organic Chemistry. By D. Ll. Hammick. Pp. viii + 258. (London: G. Bell and Sons, Ltd., 1921.) 6*s.*

MR. HAMMICK's book provides an introduction to organic chemistry suitable for junior students, and not differing in any notable way from numerous other books of similar standard. Experiments are described.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Chemical Warfare.

SIR EDWARD THORPE, in his review of Victor Lefebure's book, "The Riddle of the Rhine," in NATURE of November 10, p. 331, quotes a passage which deals with my own work during the initial stages of the war, and that of the Kaiser Wilhelm-Institut für Physikalische Chemie, of which I am the principal. The intention is to make the world believe that the materials for gas warfare were prepared by the German military authorities and chemical industry for the intended war, and that experiments with this end were carried out in my institution, if not previous to the war, at least from August, 1914, onwards.

It is always dangerous to attempt to form a correct estimate of the intentions of others from the traces of events they have left behind them. But the greatest errors must necessarily arise if an outsider tries to deduce from his own impressions the intentions of men whose ways of thinking he does not know and cannot understand.

Perhaps there might have been some ground for suspicion if Germany could have foreseen the trench warfare, and if we could have imagined that the German troops could ever be held up for weeks and months before the enemy's wire entanglements. But previous to the war, and up to the Battle of the Marne, everyone in Germany imagined that the course of the war would be a succession of rapid marches and great pitched battles, and what use would gas have been to a field army in such a war of movements? I think I may safely say that during the course of the war I became acquainted with every man of any importance in the army, in industry, and in science, who had anything to do with chemistry as applied to military offensive and defensive operations, and that I am well informed regarding the development and the course of chemical warfare. Yet among all these men I have never met one who, previous to the war or during the first two months of its course, had conceived the idea of providing the field army with gas, or had made experiments or preparations for such a purpose. We had actually first to read in the French, Italian, and English Press—as, for instance, in the *Pall Mall Gazette* of September 17, 1914—of the terrible things that were in preparation for us before we began to make similar preparations in view of the commencement of the war of position.

As regards my own institution and its work during the first months of the war, that intelligent person who, according to the passage in Lefebure quoted by Sir Edward Thorpe, observed my activities in my institute from behind a wall, lacked the gift of interpreting correctly what he saw and heard. Visitors in grey Headquarters motors did indeed come to my institution in August, 1914, though not to see me upon the subject of chemical means of warfare, but because Headquarters were very anxious to know how motor spirit could be made proof against the cold of a Russian winter without the addition of toluol. The question of gas as means of warfare did not begin to engage our attention until the first three months of war had passed.

In war men think otherwise than they do in peace, and many a German during the stress of war may have adopted the English maxim, "My country, right or wrong," but that German science and industry before the war made preparations with deliberate intent for gas warfare against other nations is an assertion that, in the interest of the necessary interdependence of the nations in the realms of science and industry, must not be allowed to go uncontradicted in so serious and respected a journal as NATURE.

F. HABER.

Kaiser Wilhelm-Institut, Berlin-Dahlem,
December 17.

HERR GEHEIMRAT HABER takes exception to the quotation I made from Major Lefebure's "Riddle of the Rhine," in the course of my notice of that book, on the ground that it implies that the German military authorities were prepared to ignore their undertaking, under the Hague Convention, to abstain from the use of asphyxiating or deleterious gases in war, if not for some time before, at least at its outbreak in the summer of 1914. I have, of course, no precise knowledge of the intentions of the German military authorities, but it was not unreasonable to surmise that these authorities, who deliberately intended to violate the treaty with Belgium, would not hesitate—as, indeed, the sequel showed—to disregard their promise under the Hague Convention if and when it suited their purpose to do so.

As regards their intentions, Field-Marshal Lord French, in his dispatch after the first German gas attack, with which Prof. Haber was concerned, wrote: "The brain-power and thought which has evidently been at work before this unworthy method of making war reached the pitch of efficiency which has been demonstrated in its practice shows that the Germans must have harboured these designs for a long time."

"It is an arresting thought," says Major Lefebure, "that even as early as 1887 Prof. Baeyer, the renowned organic chemist of Munich, in his lectures to advanced students, included a reference to the military value of these compounds"—*i.e.* to substances intended to produce temporary blindness.

Prof. Haber, it will be observed, does not explicitly deny the accuracy of the statements made by the "neutral," as quoted by Major Lefebure. Indeed, the account is too definite and specific to be set aside by irrelevancies. It is probably true that "everyone in Germany imagined that the course of the war would be a succession of rapid marches and great pitched battles." Some people on this side of the Channel were of a different opinion. But even the vain imaginings of "everyone in Germany" were not necessarily inconsistent with the use of poison gas. It was used on the Eastern front by the Germans when there was little or no question of trench warfare or wire entanglements. Prof. Haber states that he never met a single person who previous to the war or during the first two months of its course had conceived the idea of providing the army with gas. "The question of gas as a means of warfare did not begin to engage our attention until the first three months of war had passed."

The first gas attack was launched in April, 1915, so that on Geheimrat Haber's own showing this method of conducting war was engaging attention at least six months before it was used. After all, the essential point is that it was used, and first used, by the Germans, and in flagrant contravention of a solemn promise given to the world; at what precise

period they decided to be false to their obligation is a matter of secondary moment.

The implication that the Allies were contemplating the use of poison gas as early as September, 1914, is so notoriously at variance with truth that it scarcely needs serious refutation. If Geheimrat Haber could only have been present when Lord Kitchener made his dignified protest in the House of Lords, or have been a personal witness of the wave of indignation and disgust which swept over the country at the Germans' breach of the rules of war, he would not have penned his statement. We were made aware of the rumours that were being spread through the German Press, but no credence was attached to them in this country. The German Empire, even to the last, had its "reptile Press" as in the days of the Iron Chancellor. The author of the Ems telegram was an adept in the art of circulating false rumours and misleading statements, and there were those who sought to better even his example during the fateful and, for the Germans, disastrous years of the war. Even now Germany does not know half the truth.

I agree with Prof. Haber that in war-time men are apt to think otherwise than they do in peace, and this is, doubtless, particularly true of his countrymen. Their ethical standard, apparently, varies with the two conditions—which seems a sufficient reason why they should abstain from war. Those who use poison gas are not "bonnie fechters."

The menace of the continued use of poison gas in warfare is a disgrace to civilised humanity. That menace really rests with Germany. If she would undertake for the future to be true to her obligation under the Hague Convention other nations would willingly follow her example.

They were reluctantly compelled to follow it in consequence of her action at the Battle of Ypres. They would far more promptly follow her lead if she announced her intention to discontinue the practice and gave the world a sufficient assurance of good faith.

Prof. Haber could render no greater service to civilisation and humanity than to use his great influence and pre-eminent position as a man of science in inducing his fellow-countrymen to remove what is a stigma upon their *Kultur*.

T. E. THORPE.

Some Problems in Evolution.

I AM quite as averse from "wasting time in endless and futile controversy" as Prof. Goodrich, but I cannot help thinking that so long as he and Sir Archdall Reid refuse to admit what seem to most biologists obviously true statements their arguments must be answered. Prof. Goodrich states in NATURE of December 22 last that there is no contradiction between his proposition that characters, whether new or ancient, may be inherited provided they are possessed by both parents, and my reply that a character may be inherited when it is apparent only in one parent or in neither. If we omit what is common to both of these propositions it follows that in Prof. Goodrich's opinion there is no difference between "both parents" on one hand and "one or neither parent" on the other.

Prof. Goodrich complains that I do not distinguish between the variation and the resulting character. In his presidential address he maintained that the word "variation" should mean the extent or degree of difference between individuals, not a new character or assemblage of characters, such as a colour or spot on a butterfly's wing, but a difference which can be measured or estimated. "We shall then find," he writes, "that a variation is either due to some change in the complex of germinal factors or to some change in the complex of effective environmental stimuli." Here Prof. Goodrich and I are in complete agreement. Where, then, is any difference of opinion or room for controversy? The difficulty reappears in the next paragraph of Prof. Goodrich's letter, in which he states that he agrees with Sir Archdall Reid that there are two kinds of variation but only one kind of character.

Although I have honestly tried to do so, I fail to see any meaning in this statement. After all, words and terms are seldom completely satisfactory expressions of what we mean; they obtain their meaning by actual or implied reference to facts of observation. I have lately been in the habit of using the term "character" more frequently than the term "variation," because the latter is often ambiguous, but I know of no such difference of meaning between the two terms as is assumed by Prof. Goodrich and Sir Archdall Reid. How can we define characters satisfactorily except by comparison—that is, as differences between one individual, or one type, and another? For example, the rose comb is a character of certain fowls as compared with the single comb. What do we gain by asserting that the difference between the rose comb and the single is a variation, but the peculiarity of the rose comb is a character? The only questions of importance are the origin and the heredity of the rose comb. We understand one another when we say that the rose comb is inherited. It is quite superfluous to insist, as Sir Archdall Reid does, that characters are not transmitted, but only predispositions. No one supposes at the present day that the fowl's egg or spermatozoon has a rose comb, but we know that there may be something, whether we call it determinant, factor, or gene, in egg or sperm which causes the rose comb to develop in the resulting organism. And yet Sir Archdall Reid argues as though it were a remarkable discovery that characters are not present as such in the fertilised ovum from which an organism develops—an idea that has been obsolete since the Middle Ages. Therefore, he asserts, there is only one kind of character, but there are two kinds of variation. The hoof of a new-born foal has developed without any external mechanical stimulus; when I practise rowing for some time I develop epidermic corns on the palms of my hands. According to Sir Archdall Reid, these are characters of the same kind, equally innate, acquired, and inherited. Yet he has himself insisted on the distinction between characters developed under the "stimulus of nutrition" and those developed under the "stimulus of use," the same distinction, with his own peculiar misuse of the word *stimulus*, which is generally recognised by biologists.

Avoiding altogether the use of the terms "variation" and "character," we may congratulate ourselves that there is agreement on the proposition that a difference of form or structure may be due either to a difference of germinal factors or to a difference in effective environmental stimuli. And then we can get on with the investigation of the problem of the relation to evolution of these structural differences.

But, as I have endeavoured to show elsewhere, among those characters which are more or less completely hereditary there are two kinds, in a vast number of cases definitely distinguishable: the adaptive characters on one hand and the non-adaptive on the other. The adaptive characters exhibit a definite relation to habits and external conditions, and, as a rule, they exhibit recapitulation in development. The

non-adaptive characters show no relation to differences of habit or environment, and, as a rule, develop directly without recapitulation. I have instanced the adaptive characters of Pleuronectidæ (flat-fishes) on one hand and their specific and generic characters on the other. The adaptive characters of flat-fishes exhibit one of the most remarkable cases of metamorphosis and recapitulation in the whole field of zoology, while the various peculiarities of the scales, as examples among specific and generic characters, show neither recapitulation nor any relation to habits and conditions of life. Thus, instead of agreeing that there is only one kind of character, I find it necessary to distinguish three kinds, one due to the effect of an external stimulus on the individual, and not apparently inherited, and two kinds which are hereditary.

J. T. CUNNINGHAM.

Chiswick, December 31.

Optical Observation of the Thermal Agitation of the Atoms in Crystals.

ACCORDING to the theory of specific heats developed by Debye, Nernst, and others, the thermal energy of a solid is made up of the energy of elastic vibrations in its material, the frequencies of such vibrations ranging from very small values up to a maximum limit determined by the ultimate molecular or atomic structure. On this view it is clear that at ordinary temperatures the density of a solid, and therefore also its refractive index if it be of transparent material, would vary arbitrarily from point to point about its mean value. In other words, a transparent crystal cannot be regarded as optically homogeneous even with reference to the comparatively long waves which constitute ordinary light. It follows that a certain proportion of the energy of a beam of light traversing the medium would be deviated laterally and appear as scattered light, the intensity of such scattering being a measure of the thermal agitation within the crystal. That some such effect must occur has already been pointed out by Sir Joseph Larmor (*Phil. Mag.*, vol. 37, p. 163, 1919), but no theoretical discussion of its magnitude appears so far to have been put forward. It has occurred to the present writer that the effect to be expected may be found in the following way:—If the principles of statistical mechanics and the equipartition of energy were applicable in the case of solids, precisely the same considerations which determine the molecular scattering of light in fluid media would enter here as well, and the scattering coefficient would be given by the Einstein-Smoluchowski formula

$$\frac{\pi^2}{18}\cdot\frac{RT\beta}{N\lambda^4}\cdot(\mu^2-1)^2(\mu^2+2)^2,$$

where β is the compressibility of the solid, μ is its refractive index, λ is the wave-length of the light, and R, T, N are the constants of the kinetic theory. It is known, however, that the heat-content of solids at the ordinary temperature is much less than that indicated by the equipartition principle, the deficiency being most marked for substances, such as diamond, having a high "characteristic temperature." The scattering coefficient given by the preceding formula must therefore be diminished in the ratio which the actual heat-content at the temperature of observation bears to the heat-content indicated by the equipartition principle. This correction-factor may be found from the experimental data for the specific heats at low temperatures given by Nernst, Lindemann, and others.

Calculations made in the way indicated above show that transparent quartz should scatter light $9\frac{1}{2}$ times as strongly as dust-free air at normal temperature and pressure. A scattering of approximately this magnitude in clear quartz was detected photographically by R. J. Strutt (now Lord Rayleigh) (Proc. Roy. Soc., vol. 95, p. 495, 1919), but was ascribed by him to inclusions which he assumed were present in the crystal. It is clear from what has been said above that the effect observed by him was actually due to the thermal agitation of the atoms in the crystal. The present writer has succeeded in demonstrating the scattering of light in clear quartz by direct visual observation. For this purpose a block of the crystal with smooth polished faces is immersed in a tank of clean distilled water to minimise surface-reflections and a converging lens is used to bring a beam of sunlight to a focus within the crystal. The blue track of the beam within the crystal may then be readily observed, and its intensity can be judged by comparison with the scattering of the beam in saturated ether vapour. The writer has had the pleasure of exhibiting the phenomenon to Sir W. J. Pope and other distinguished callers at his laboratory.

Transparent rock-salt which has a low characteristic temperature and shows a marked "Debye-effect" in experiments on X-ray reflection exhibits a very strong scattering of ordinary light. The increase of the scattering with rise of temperature may readily be observed with it.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta, November 19.

A Fossil Buttercup.

WHEN we examine a catalogue of fossil plants, such as that for North America recently published by Knowlton, we are struck by the enormous number of recorded species, and readily receive the impression that the flora of former ages is quite well known. It is only when we make a more critical investigation that we perceive the great gap in our present knowledge. We do, perhaps, know a fair proportion of the trees and deciduous-leafed shrubs of a number of geological periods, but when we look for the herbaceous flora the limitations of our knowledge at once appear. Thus the Ranunculaceæ, an extensive family in the present North American flora, do not furnish a single definitely recorded fossil in the same area. Dawson in 1875 vaguely referred to a Thalictrum, without specific name, supposedly from the Eocene, but it is not to be taken seriously. Schenk thought the fossil genus Dewalquea presented a certain analogy with Helleborus, but it is now referred to quite another family. It is, of course, impossible to suppose that the Ranunculaceæ were absent from North America during Tertiary times; they simply must have escaped preservation or observation. To those who would see in the geological record a proof that herbaceous plants did not exist in the past, or were extremely rare, we can only reply that the record as it stands proves too much. To accept it at its face-value postulates the impossible. The general proposition that the herbaceous flora is, *on the whole*, more recent than the woody may be valid, and has much to recommend it.

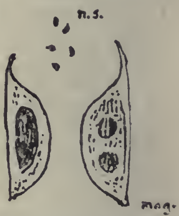


FIG. 1.—Achenes of *Ranunculus florissantensis.*

With regard to the Tertiary Ranunculaceæ of North America, we can fortunately rescue them from utter oblivion. Several years ago I found some slabs of Miocene shale at Florissant, Colorado, plentifully besprinkled with small dark fossil seeds. The exact locality is the railroad cut just east of the town.

These seeds were not studied at the time, but they are now seen to agree excellently with those of Ranunculus. They are, properly speaking, achenes, about 1·7 mm. long and 1 mm. broad, with a fairly long moderately curved beak. The general form approaches that of *R. pennsylvanicus*, but the achene is less robust. The fossil may be known as *R. florissantensis* n. sp. Ranunculus has a single seed in the achene. It has been definitely determined for *R. acris* at least that there is only one ovule. Our fossils, however, very distinctly show two, after the manner of Hydrastis. They were evidently small and dry at maturity, as in Ranunculus, and the most mature ones contain only one seed, dark and clearly outlined. It would be worth while to investigate the immature achenes of numerous species of Ranunculus to determine whether any start with two ovules, one aborting, as I have determined to be the case in Malvastrum. Heer has described a very similar Ranunculus seed (achene) from the Miocene of Oeningen in Baden.

T. D. A. COCKERELL.

University of Colorado, Boulder, Colorado,
December 8.

The Absorption of Fluorescing Sodium Vapour.

ACCORDING to Bohr's theory concerning the origin of spectral lines, electrons in the atoms of sodium vapour under the influence of exciting D radiation are displaced from their normal 1·5 S orbit to the $2p$ orbits. During the return of the electrons to their normal orbit the so-called "resonance" radiation, first observed by Wood (*Phil. Mag.*, November, 1905, and "Researches in Physical Optics," part 2, p. 166), is re-emitted as fluorescent light. It has been suggested, therefore, by more than one observer (Foote and Meggers, *Phys. Rev.*, vol. 15, part 4, p. 323, and *Phil. Mag.*, vol. 40, p. 80, 1920) that fluorescing sodium vapour should absorb lines of the first and second subordinate series $2p_{,2} - ms$ and $2p_{,2} - md$. To test this point I have

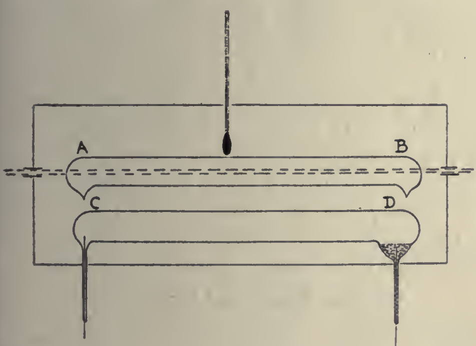


FIG. 1.

made use of the experimental arrangement outlined below. While a negative result was obtained, it seems worth while to record the trial, along with one or two suggestions for a more rigid test which I am not able to make at present.

A narrow beam of light from a Nernst lamp traversed the tube AB, some 25 cm. long, into which some sodium had been distilled in high vacuum (Fig. 1). By means of a lens the light was focussed on the slit of a Hilger constant-deviation spectroscope. Directly below the sodium tube was a sodium–potassium alloy "lamp" CD, a slight modification of the type recently described by Neuman (Proc. Phys. Soc. London, vol. 33, part 2, February 15, 1921). Both tubes were enclosed in an electric oven, by means of which they could easily be heated to 300° C. or higher. For two reasons it seemed to the writer that this lamp should be most suitable. In the first place, resonance can best be excited by very narrow spectral sources, and it had been shown that the light from the lamp consisted almost entirely of D lines of narrow width. Again, it could be operated at temperatures at which resonance is obtained in sodium vapour, so that it was possible to place the two tubes side by side in the same oven.

At temperatures ranging from 200° C. to 300° C., therefore, observations were made to see if there was any difference in the absorption spectrum when the exciting lamp was "on" and "off." The D absorption lines were easily visible, but not the slightest difference could be detected in the two cases. It is possible, however, that with an improved arrangement the absorption looked for might occur. The lines of the subordinate series most likely to be absorbed are the first members, which, however, are in the infra-red region and could not be observed visually. A much better test, therefore, would consist in photographing with dicyanine-stained plates in the hope of observing absorption of the doublet λ 8195 and λ 8184. Again, the intensity of the exciting light may not have been great enough to put a sufficiently large number of atoms in the desired state. This difficulty would be lessened by the use of two or three lamps, or possibly by adapting for use with sodium some such arrangement as was used by Füchtbauer (*Phys. Zeit.*, vol. 21, November 1 and 15, 1920) for observing resonance in mercury vapour. Finally, a longer absorption tube obviously would be more desirable. With improvements such as are suggested a much more rigid test could be made.

JOHN K. ROBERTSON.

Queen's University, Kingston, Canada,
December 17.

The Message of Science.

MR. W. ROBERTSON's letter in NATURE of January 5 is very timely. May I invite him and those his letter has interested or impressed to put into practice, in Middlesbrough or any other town, the "most practical suggestion of immediate value" he describes, with one important addition. Some of us have recently been striving to get his suggestion, thus widened and clinched, made operative in other British centres of population on behalf of the British Science Guild, the objective of which comprehends the exact duty Mr. Robertson acclaims and the methods of which in a new campaign have been dictated by a lively sense of provincial and metropolitan needs in the harnessing of science to important public tasks.

Our methods begin just where those of so many other people leave off. We ask local scientific societies and organisations and all who desire to make their special scientific equipment of use to their times to establish touch at once with the important local organisations and groups in which business men, administrators, and the occupational classes gather, and with them to consider "the progressive connecting of science with individual and corporate conduct," not in general, nor on another continent, but in their own towns (where facts can be known and methods tested), and in any of the problems on which much public time and public money have inevitably to be spent. That suffices for a beginning.

Many are feeling to-day that science should become, and can become, the "chief formative factor of modern

life." It will not become anything of the sort of its own volition, as scientific workers are not usually interested in broad problems outside their own particular fields, and those who have to be forced into the work are best out of it.

Functioning best begins with a real task, however difficult, before the particular community, preferably the first task which involves large sums of money, large expenditure of time and of energy, and considerable risk to human life. These tasks exist in bewildering profusion. The knowledge, without which they cannot even be stated correctly, exists also, and the prize of efficient performance cannot be won apart from its application. With human contact and the common sense of an adaptable race, tasks and knowledge can approximate each to each, and the first step in the unity of purpose which science can best bring to national life may be taken to-day in any city of the country. J. J. ROBINSON

(Secretary of the Parliamentary Committee of the British Science Guild).

6 John Street, Adelphi, London, W.C.2, January 9.

Terrestrial Magnetic Disturbances and Sun-spots.

MAY I add a few remarks on Mr. Evershed's interesting letter on this topic (NATURE, December 29, p. 566), and supplementary also to my former letter (NATURE, October 27, p. 272). The protracted magnetic storm of May 12–21, 1921, after a lull on May 18, resumed an active phase on May 19–21. In my former letter I traced a sequence of magnetic disturbances, in connection with that of May 21, which extended to October 5. I may now add that the sequence has persisted until December 24, that is for 217 days, embracing eight synodical rotations of the sun, with a mean period of 27·13 days. The corresponding mean sidereal period would be 25·25 days, or 14·26° per day. This is Carrington's rotation period for latitudes 10° to 15°, and agrees closely with the sidereal period found by Mr. Evershed for the main series of disturbances from March 22 to September 29, 1921.

With regard to the series of disturbances from January 1 to November 21, 1920, which was also recorded at this observatory, Mr. Evershed deduces the equivalent solar period as 25·22 days, which is Carrington's value for spots about latitude ±10°. He remarks: "The slight difference of period compared with that obtained from the 1921 series does not make the evidence for these sequences less convincing." To my mind, in this particular case at least, it makes the evidence more convincing, because the mean latitude of the sun-spot group observed from December, 1920, to May, 1921, was about −6°, and, in fact, in the January appearance extended from 0° to −12° in latitude. In the case of the 1921 group, May 9–17, the mean heliographic latitude was +0·8°, but it extended north of the equator at least 5° in latitude, sufficiently in accord with a synodical rotation period of 27·13 days. A. L. CORTIE.

Stonyhurst College Observatory, January 2.

Reform of the Calendar: Mean Value of the Year.

I SEE there is to be a meeting at Rome in 1922 to consider questions concerning the calendar. I should like to direct attention to the fact, apparently little known—I, at least, have never seen it in any book—that if we make the year equal to 365 218/900 days we get a very good approximation, and one which can be applied by omitting leap-years at certain complete centuries, something like what is being done under the present Gregorian rule. If we say that "a century-year shall be a leap-year only if it gives a remainder of 2 or 7 when divided by 9," we have a rule which is much more approximate than the Gregorian rule, and one which has been followed *de facto* since 1582 (year of the Gregorian reform). The new rule would not differ in its application from the Gregorian rule before the year 2400. The Gregorian year, 365 97/400 days, differs from the true tropical year by 26 seconds; if the above modified rule were introduced the difference would be reduced to 2 seconds.

The "Encyclopædia Britannica" in the article "Calendar" mentions the value 365 31/128, which, no doubt, is very approximate (difference from true year 1 second), but depends on the awkward cycle of 128 years; and, besides, its application would mean a new break in the way of introducing, or rather suppressing, leap-years. ARTHUR ROSE-INNES.

Yokohama, November 27.

Units in Aeronautics.

PLEASE allow me to protest against Mr. A. R. Low's attack in NATURE of January 5, p. 12, on the "slug," which was not introduced by Prof. Bairstow, but probably by Prof. Fleeming Jenkin about thirty years ago. The slug does not lead to any evasion of Newton's laws any more than the poundal which was introduced by Prof. James Thomson. All such terms are useful so long as they are precisely defined and correctly understood; in recent years a distinguished German mathematician has been striving to introduce Prof. Thomson's "radian" in place of "Einheitskreisbogenlänge."

The contempt common amongst chemists and physicists towards so-called "engineers' units" is without justification. The chemist or physicist derives his unit of force from a definition of mass and acceleration, whereas the engineer derives his unit of mass from a definition of force and acceleration. The engineer's reason is that his problems come to him in terms of forces, and he wants his solution in the same units. Engineers on the Continent use the kilogram as the unit of force, and derive a metric slug in terms of the metre and second.

The ideologist is fond of so-called "absolute" units, but the physical meaning of Newton's or other laws is often made more clear when units are chosen conveniently. An ordinary man cannot realise a force of a dyne, though an insect might collapse under it; and while an astronomer measures distances in light-years, the peasant uses hours of walking and the spectroscopist μ. It is unlikely that the British or foreign working-man will ever ask for his beer in cubic centimetres: the unit is inconveniently small.

Chiswick, January 9. H. S. ROWELL.

A Curious Physiological Phenomenon.

THE phenomenon to which attention is directed by Mr. F. C. Dannatt in NATURE of December 22, p. 529, is an exceedingly interesting one, and may be the explanation of what occurs in "table turning" and "hat turning." Many have, no doubt, seen the hat, upon which many fingers are resting, move in a very peculiar manner, and it is difficult to believe that those who are engaged in the exhibition are not telling the truth when they declare that they are not aware that they are the cause of the movements. An essential element of the game is that the weight of the arms should be carried by the muscles, and it is interesting to learn that such strained conditions lead to involuntary muscular movements.

R. M. DEELEY.

Tintagil, Kew Gardens Road, Kew, Surrey, December 24.

Oceanography of the Gibraltar Region.

By DR. JOHS. SCHMIDT.

THE first month spent at sea by the *Dana* Expedition was occupied with investigations in the boundary area between the Atlantic and the Mediterranean—*i.e.* in the Bay of Cadiz, the Straits of Gibraltar, and the Western Mediterranean as far as Algiers. We had worked there before, in 1908–10, with the *Thor*. We were, therefore, not unacquainted with local conditions, and it was very interesting to compare the new investigations with the old. The expedition was particularly fortunate in being able, during this month, to enjoy the co-operation of Dr. J. N. Nielsen, who, from his participation in the *Thor* expeditions, is perhaps more familiar with the hydrography of these waters than anyone else. The remaining scientific staff of the expedition consisted of Messrs. P. Jespersen and A. V. Tåning, both ichthyologists and trained in the work of general marine biology; K. Stephensen, as expert in crustaceans; while the physical and chemical investigations were carried out by Messrs. J. Olsen and N. C. Andersen, the last-named being physician to the expedition.

Previous investigations—British, Danish, and Norwegian—have given us the main features (but no more) in the transfusion of water which takes place between the Mediterranean and the Atlantic. The most striking difference between Mediterranean and Atlantic water is in the salinity. Owing to the great evaporation, the water in the Mediterranean is of higher salinity than the Atlantic water—viz. more than 38 per mille (that is, 38 grams of salt in 1000 grams of sea-water) as against about 36–36·5. The less saline Atlantic water flows through the Straits of Gibraltar into the Mediterranean as a surface current. Deeper down, the Straits of Gibraltar are filled with salter water, which, coming from the Mediterranean, moves westward over the comparatively shallow threshold, in places only 400 metres down, formed here by the sea floor, which falls away steeply both to the east and west.

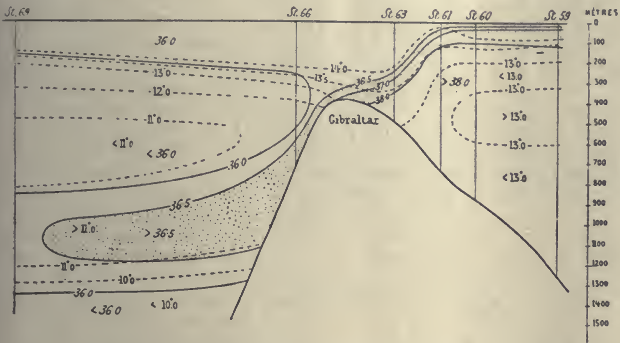


FIG. 1.—Showing isohalines (figures in italics) and isotherms. Hydrographical section through the Straits of Gibraltar from the investigations of the *Thor*, February, 1909. (Schmidt, Nielsen, and Jacobsen, 1910.)

On reaching the western edge of this ledge, the Mediterranean water pours down, like a veritable submarine waterfall, towards the depths of the Atlantic Ocean (Fig. 1). It does not, however, reach the bottom; being warmer, and therefore lighter, than the bottom water of the Atlantic, it spreads out as an intermediate layer in the Atlantic, which is recognisable in that it is of higher salinity than the water-layers above and below. J. N. Nielsen and F. Nansen have previously demonstrated the existence of this intermediate layer of Mediterranean water—or, more correctly, mixed water—right up to the west of the British Isles. At the stations of the *Dana* Expedition between Madeira and the Cape Verde Islands (Stations 1142, 1152, 1156, 1157, 1159) we found it at depths of about 1000–1500 metres, with a salinity naturally decreasing towards the south, but varying from about 35·7 per mille at Madeira, to about 35·03 near the Cape Verde Islands.

Up to now we have referred only to the outflow of Mediterranean water into the Atlantic. Fig. 2 gives a picture of the inflow of Atlantic water into the Mediterranean, based on the investigations of the *Dana* Expedition in the waters between Oran, Algeria, and the south coast of Spain. The figure represents a vertical section of the upper 400 metres of sea through our three stations 1119, 1120, and

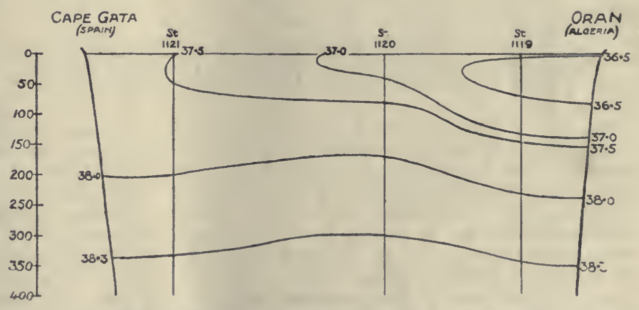


FIG. 2.—Hydrographical section through the westernmost portion of the Mediterranean as shown by the *Dana's* stations 1119, 1120, and 1121, about October 1, 1921. The isohalines for 36·5, 37·0, 37·5, 38·0, and 38·3 per mille salinity are shown. The depths are given in metres. The section shows that the inflowing Atlantic water (salinity less than 36·5 per mille) follows the coast of Africa.

1121, showing the depths and the course of the isohalines. It will be seen that unmixed Atlantic water, of a salinity less than 36·5 per mille, flows in along the north coast of Africa. Midway (Station 1120) we find a slight, and farther north, off the coast of Spain (Station 1121), a somewhat more pronounced, admixture of Mediterranean water. From this it must be concluded that the velocity of the east-going current is at its highest close in to the African shore, and lowest off the coast of Spain, which is also in accordance with fact. The section further shows that the inflow of Atlantic water is a comparatively superficial phenomenon, almost pure Mediterranean water being found at a relatively slight depth.

For nearly a week at the beginning of October the *Dana* remained at Gibraltar in order to study the inflow of Atlantic water and the accompanying migration of pelagic organisms through the Straits. On several occasions continuous investigations were made, as, for instance, from 9 p.m. on October 8 to 6 a.m. on October 10, when series of water samples, with observations of temperature, were taken every three hours; in the intervals between hydrographical observations fishing with pelagic nets was carried out at various depths. All these investigations were made at the same spot, about the middle of the Straits, with Tarifa, in Spain, to the west-north-west. The investigations showed that both physical and biological conditions varied greatly in the course of the twenty-four hours. Temperature and salinity, for instance, did not remain constant at a given depth throughout that time. Fig. 3 shows how water of 14° C. and 37·4 per mille salinity—characteristic values for temperature and salinity of mixed Atlantic and Mediterranean water—changes its level within the twenty-four hours. It will at once be noticed that the changes are periodical, and a closer investigation of the times indicated places it beyond doubt

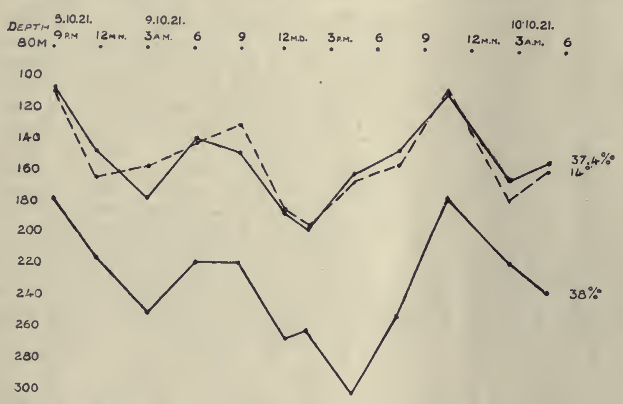


FIG. 3.—Straits of Gibraltar: St. 1138, lat. 35° 59′ N., long. 5° 30′ W. Continual observations at the same spot from 9 p.m. October 8 to 6 a.m. October 10, showing periodical shifting of the level at which salinities of 37·4 and 38·0 per mille and a temperature of 14° C. are found during the period of observation. The depths are given in metres.

that we have here to deal with a tidal phenomenon, albeit the magnitude of the alteration in level would appear to be also dependent upon other factors, such as the direction and force of the wind.

A comparison of the contents of the pelagic nets throughout the night at our station off Tarifa proved highly interesting, but raised questions which I soon perceived were to be solved only by a far longer stay at this point than the *Dana* could afford. I will take one example. A net drawn horizontally at about 150 metres' depth on October 8 for two hours from 10.15 p.m. brought up about 80 litres of matter, consisting almost exclusively of a siphonophore (Diphyes). Towards morning Diphyes had disappeared, the contents of the net from 150 metres' depth then consisting chiefly of Salpæ and a schizopodous crustacean. The same phenomenon was repeated next night: first scarcely anything but Diphyes, and later on almost exclusively Salpæ. Our hauls thus showed that the depth at which Diphyes and Salpæ are found is subject to alteration, but the question then arises whether such alteration is due to active movement of the organisms in question, or to a purely passive shifting answering to the change in level of the water layers effected by the action of the tides.

A comparison of the pelagic fauna on both sides of the Straits of Gibraltar was likewise of much interest. As the main result it may be stated that several species were common to both areas, while others were found only west of Gibraltar. Among the latter may be quoted, of fishes: *Argyropelecus Olfersi*, *Vinciguerria Sanzoi*, *Myctophum laternatum*, and *M. Valdivia*, with various murænoid larvæ (*Leptocephalus Synaphobranchi pinnati*, *L. latissimus*, *L. lanceolatoides*, etc.). In contrast to these I may mention the larvæ of the common freshwater eel (*Leptocephalus brevirostris*), which pass through the Straits of Gibraltar in enormous numbers. This phenomenon was one of particular interest to the expedition, and I hope to be able to say more about this to readers of NATURE later on. Here again we are faced with new problems. Why, for instance, should certain pelagic species stop just outside the Straits of Gibraltar, and others, which out here may be taken in the same haul with the former, not be found in the Mediterranean? Are they killed immediately on entering the Mediterranean by the natural conditions prevailing there, or are they able in some way, despite their pelagic habit, to maintain their position—possibly by means of vertical migrations? Various features would seem to suggest that it is not sufficient to regard the problem solely from the point of view of direction of current as found by

the use of a current meter, but that other factors also come into play. Otherwise it would be difficult, for instance, to understand how certain pelagic species of fish (*Myctophum glaciale* and *M. Dofleini*, *Stomias boa*, etc.) can at all seasons occur in far greater quantities—have a maximum of density—in the Alboran Sea (the westernmost part of the Mediterranean, between Spain and Morocco) than either west or east of there, despite the fact that the surface layers are in constant movement towards the east. This is actually the case, as was first shown by A. V. Tåning and Vilh. Ege on the basis of material from the *Thor* expeditions. The *Dana* Expedition has proved the same thing. Comparatively few specimens occur west of Gibraltar and east of Oran, but in the Alboran Sea itself great quantities of all three species were found, so that the contents of a single net might show, for instance, more than 1500 specimens, especially *Myctophum glaciale*.

In conclusion I cannot refrain from emphasising the extreme importance an intensive study of the Straits of Gibraltar and adjacent waters would have for general—physical and biological—oceanography. When, at the commencement of October, I was obliged to leave this area in order to take up the other tasks allotted to the *Dana* Expedition, it was with the conviction that the expedition would in all probability have been able to do more for the cause of oceanography in general by keeping station at Gibraltar during the ten months we have for work, than by cruising about the ocean. Being so convinced, I venture to hope that British naturalists may soon take up this important task, which Great Britain, with Gibraltar as a base, has unique opportunities for dealing with. A research vessel stationed at Gibraltar would take but half an hour to arrive on the scene of operations, the meeting-place of two deep seas. The saving in time and coal, and the unparalleled opportunities of utilising all favourable weather conditions for oceanographical work, are self-evident.

(On board the *Dana*, at San Vicente, Cape Verde Islands, November 1, 1921.)

Photographic Studies of Heights of Aurora.

By Dr. C. Chree, F.R.S.

THE two publications referred to below,[1] by Prof. Carl Störmer, of Christiania, merit the attention of all interested in the physics of the atmosphere. As is generally known, Prof. Störmer discovered a satisfactory method of measuring the height and position of aurora by means of photographs taken simultaneously at the two ends of a long base. The photographs include two or more stars, the exact positions of which in space are ascertainable, the precise time of taking the photographs being known. The difference between the positions of the aurora relative to the stars in the two photographs enables the necessary calculations to be made.

The first memoir gives a very full account of photographs taken in the spring of 1913 at two Norwegian stations, Bossekop (B.) and Store Korsnes (K.), 27·5 km. apart, near latitude 70° N. Some of the results have been already discussed in a series of papers enumerated on p. 7, which have appeared in different publications, especially *Terrestrial Magnetism and Electricity*, the *Astrophysical Journal*, and the Paris *Comptes rendus*. But the present memoir, besides summarising these, contains much new matter. In chaps. 1 and 2, pp. 8–37, there is a description of the apparatus and equipment and of the methods of observation. This is intended to be supplementary to descriptions already given, but describes various improvements and simplifications. Chap. 3, pp. 38–156, is a complete journal in chronological order of all the 336 pairs of photographs discussed. Besides the date and hour and time of exposure, values are given of the parallax of each selected auroral point (*i.e.* the angle subtended at the point by the 27.5-km. base), its astronomical co-ordinates (altitude and azimuth), and several calculated data, including the height of the point above the ground, and the distance from Bossekop of the point itself and of the corresponding point on the earth's surface vertically under it. The vertical heights vary from 87 to 323 km., the horizontal distances from Bossekop from 5 to 780 km. Some of the more notable auroras are discussed in considerable detail. The 336 pairs of photographs appear in plates 1 to 28, each plate containing twelve B. (Bossekop) and the corresponding twelve K. (Korsnes) photographs. To each pair of photographs there answers a diagram showing the stars used in the calculations, the positions of the auroral points, usually distinguished by numerals, and dashed lines to represent the parallaxes.

We reproduce two pairs of B. and K. photographs. One (Fig. 1) represents an auroral curtain in which twenty-one points were measured. The nearest point (towards the apparent tops of the photographs) was at a horizontal distance of 99 km. from Bossekop, the most remote point (near the lower left-hand corner) at a distance of 265 km. The heights measured varied from 90 to 130 km. Fig. 2 represents a band having the right-hand edge exceedingly sharp and luminous. The twelve points measured are shown in the key diagram (Fig. 3). Their heights varied only from 102 to 108 km. The horizontal distances from Bossekop of points 1 and 12 were respectively 61 and 178 km., and their parallaxes were 13·1° and 7·7°. The stars used were α, β, and θ Aurigæ. C_1 and C_2 represent the positions relative to the stars of the centres of the plates for Bossekop and Korsnes. The other details as to the stars refer

[1] Carl Störmer: "Rapport sur une expédition d'aurores boréales à Bossekop et Store Korsnes pendant le printemps de l'année 1913." *Geofysiske Publikationer*, vol. 1, No. 5. Pp. 269+104 plates. (Kristiania, 1921.)
"Exemples de rayons auroraux dépassant des altitudes de 500 kilomètres au-dessus de la terre." *Geofysiske Publikationer*, vol. 2, No. 2. Pp. 5+2 plates. (Kristiania, 1921.)

to the Bossekop photograph. The arrow-heads radiating from each star show the directions of the star's declination (δ) and altitude (h) circles and of the auroral parallax (p). The numerals 39, 43, 46 represent degrees of altitude. The azimuths of the stars, 180°–89·5°, etc., are also shown. The dotted lines represent the parallaxes in magnitude and direction.

K. B.

FIG. 1.—Auroral curtain photographed at Korsnes and Bossekop.

B. K.

FIG. 2.—Auroral band photographed at Bossekop and Korsnes.

The 336 key diagrams occupy plates 33 to 87. Finally, there are charts numbered 1 to 32, included in plates 90 to 104, which show the geographical positions of the points on the earth vertically under all the auroral points dealt with. The observational data are thus presented in an extremely systematic fashion. Chap. 4, pp. 157–212, includes a mathematical investigation of the variation in the inclination of the trajectory of an electrified corpuscle to the direction of magnetic force, the magnetic field having a potential. In the applications the earth's field is supposed to be given with sufficient accuracy by the first-order Gaussian terms. The corpuscle is supposed to have emanated from the sun, and its course is considered after it has come to within 500 km. of the earth's surface. The inclination of the trajectory to the magnetic lines of force tends to increase as the corpuscle approaches the earth. If the angle attains to 90° the corpuscle retreats. The energy may be absorbed while the corpuscle is approaching or while it is retreating, or some may remain after the retreat has carried the corpuscle outside the atmosphere. What happens is

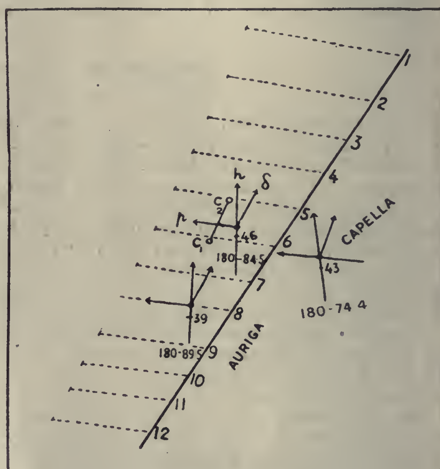


FIG. 3.—Measurements of points on Fig. 2.

shown to be largely dependent on the constitution of the atmosphere. The author assumes that throughout the troposphere, the upper limit of which is put at 10·5 km., air is constituted exactly as at the earth's surface. But higher up in the stratosphere the several constituents, nitrogen, oxygen, argon, neon, helium, krypton, xenon, and hydrogen, behave independently. The author essentially follows Mr. Jeans, rejecting Wegener's hypothetical gas geocoronium. According to his calculations, p. 173, helium is the most important gas between heights of 110 and 200 km., hydrogen preponderating at greater, and nitrogen at lower, levels. These are practically the only gases that count when we consider how far down an auroral ray can come in the atmosphere. Separate calculations are made of the absorption of cathode and β-rays on one hand, and of α-rays on the

other. A number of special cases are worked out for both positive and negative rays, and the luminosity at different heights is considered.

Chap. 5, pp. 213–222, comparing theory with observation, gives a brief analysis of the observed heights and contains some historical matter. The α-ray theory of aurora is credited to Prof. Vegard, who has now, however, abandoned it. The author's own conclusions seem, on the whole, in general accord with those now held by Vegard. He considers that the luminosity phenomena of aurora cannot be explained on the α-ray hypothesis except for what he calls "plaques pulsatoires." The most likely sources of all other auroras, he thinks, are cathode rays.

On pp. 221–22 is an interesting statement of what Prof. Störmer takes to be the auroral problems now calling for attention. The observational problems include height measurements in the Arctic and Antarctic, and the investigation of the auroral spectrum at different levels. The first theoretical problem remaining is to take account of the mutual electro-magnetic actions of the corpuscular currents, as well as of the action of the magnetic fields of the earth and sun. "On pourra alors . . . étudier jusqu'à quel point les objections de Shuster (Schuster) relatives à des faisceaux cathodiques dans l'espace sont bien fondées ou non." A second theoretical problem is to apply the knowledge we may gain of the auroral corpuscles to the study of solar physics.

The second paper by Prof. Störmer relates to auroral measurements made during a great magnetic storm on March 22–23, 1920. Use was made on that occasion of seven stations giving bases varying in length from 26 to 250 km. Of the heights measured, six exceeded 500 km., one being 607 km. The plates attached to the paper are enlarged negatives of the photographs obtained. The photograph reproduced here (Fig. 4)

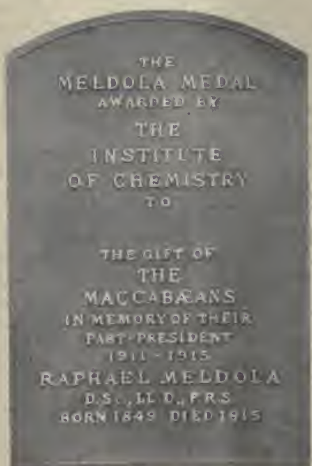
Fig. 4.—Aurora during the magnetic storm of March 22–23, 1920.

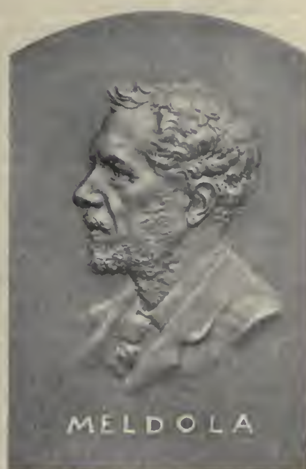
is a positive, which we owe to the kindness of Prof. Störmer. The demonstration of the existence of a sensible atmosphere at heights exceeding 500 km. is a notable event.

The Meldola Medal.

Raphael Meldola was a man of remarkable versatility, eminent to an unusual degree in several sciences—chemistry, biology, entymology, astronomy—and of unbounded energy. How broad his sympathies and interests were, and how distinguished his services, should be sufficiently apparent from the fact that he was elected to the presidential chairs of the Essex Field Club, the Entomological Society, the Chemical Society, the Society of Dyers and Colorists, the Society of Chemical Industry, and the Institute of Chemistry. Apart from the distinctions connected with his scientific pursuits, Meldola was held in high honour among his own people as president of the Maccabæans, a society in London consisting mainly of Jewish professional men devoted to the promotion of the interests of the Jewish race.

That society has instituted a medal in order to perpetuate his memory, and has arranged with the council of the Institute of Chemistry that the





The Meldola Medal.

Meldola medal be presented annually for the most meritorious chemical work of the year ending on the last day of December preceding the award. The award is not to be restricted to any particular branch, but the administrators, who are the council of the institute and a member of the Maccabæans appointed by their committee, will have primary regard to work done in analytical chemistry. The award, however, is restricted to British subjects of not more than thirty years of age at the time of the completion of the work—a condition seldom, if ever, attaching to awards of this kind. It is intended to afford encouragement to young investigators and to imply recognition of high merit—which is more frequently accorded in later life to those who have long achieved distinction. The medal, which is in bronze and is here illustrated, has been designed and executed by Mr. Frank Bowcher.

The council of the Institute of Chemistry hopes that the first award may be made at the annual general meeting of the institute on March 1 next. Chemists are invited at any time prior to Friday, January 20, to direct attention to published work of distinctive character, preferably in analytical chemistry, carried out during 1921. Such communications should be headed "Meldola Medal," and should be addressed to the registrar of the institute, 30 Russell Square, W.C.1.

Meldola died on November 16, 1915, and many will remember that in 1917, by subscription among his friends, two portraits of him, by Mr. S. J. Solomon, R.A., were presented to the Royal Society and the Institute of Chemistry. The medal affords an additional fitting tribute to one of the most notable men of science of our time.

Obituary.

DR T. A CHAPMAN, F.R.S.

DR. THOMAS ALGERNON CHAPMAN died at Reigate on December 17 last after a long period of failing health, in the eightieth year of his age. His father, Dr. Thomas Chapman, of Glasgow, was in his day an entomologist of high repute, and the life-long devotion of the son to the study of insects commenced at an early age. After graduating in medicine (with honours) and surgery at Glasgow and Edinburgh, Dr. Chapman was for a time resident physician and surgeon to the Glasgow Royal Infirmary, and in 1866 he received an appointment to the Joint Counties Asylum at Abergavenny. He afterwards became Medical Superintendent to the County and City Asylum of Hereford, and during his tenure of this office, from which he retired in 1895, he contributed several important papers to the *Journal of Mental Science*.

A keen and successful collector, and a delightful companion in the field, Dr. Chapman was, in addition, one of the most philosophical of naturalists and the most accurate and painstaking of observers. His long series of entomological memoirs—the Royal Society's Catalogue and the "Zoological Record" enumerate more than 250 separate papers published by him from 1868 onwards in the current magazines and the Transactions of the Entomological Society of London—regarded as a whole, takes rank among the most important contributions to the science of entomology by a single individual in recent years. Some of his early papers deal with the life-histories of certain wood-feeding Coleoptera of great economic importance and interest, but the great bulk of Dr. Chapman's work relates to the Lepidoptera, chiefly from the bionomic and taxonomic aspect. Of late years he devoted considerable attention to the biology of sawflies, and the last paper from his pen on this subject appears in the *Entomologists' Monthly Magazine* for January.

Among the most important of Dr. Chapman's memoirs are those on the value of pupal characters in the classification of the Lepidoptera; on the life-history of the Micropterygidæ, and the true relations of these singular insects, for which he recently proposed a new order, the Zeugloptera; and the life-histories, in some cases previously unknown, of many species of British and European Lycænidæ or "blue" butterflies, and the association of their larvæ with ants and other insects, the material for these researches being acquired in many visits to the Alps and other parts of the Continent in his later years. The solution of the mystery of the larval and pupal life of *Nomiades arion*, for so many years an entomological enigma, is in large measure due to his acumen and patient observation.

Dr. Chapman became a fellow of the Entomological Society of London in 1891, served repeatedly on the council, and was vice-president of the society on no fewer than four occasions; but, to the great regret of his colleagues, he could never be induced to assume the office of president, which was long open to his acceptance. He joined the Zoological Society in 1898, and in 1918 he was elected a fellow of the Royal Society. His genial and engaging personality will be greatly missed by his wide circle of friends and fellow-workers, and very few men were more highly and deservedly esteemed in life or are more deeply regretted in death. J. J. W.

IT is announced in *Science* that PROF. HENRY TURNER EDDY, professor emeritus of mathematics and mechanics in the University of Minnesota and dean emeritus of the graduate school, died on December 18 last at the age of seventy-seven years. Prof. Eddy was professor of mathematics, astronomy, and civil engineering in the University of Cincinnati for sixteen years, and went to the University of Minnesota in 1894 as professor of engineering and mechanics. Later he became professor of mathematics and mechanics. He served both as secretary and vice-president of the American Association for the Advancement of Science, and was also a member of several other learned societies in America.

Notes.

ALL friends of humanity will welcome with a profound sense of relief the intimation that the representatives of Great Britain, France, Italy, Japan, and the United States, assembled at the Washington Conference, have agreed to the American proposal to prohibit the use of poison gas in warfare. As Mr. A. J. Balfour pointed out, in announcing the adherence of Great Britain, Mr. Root's resolution was, in effect, a re-affirmation of international law as it existed prior to 1915, when it was deliberately violated by Germany. He was conscious, as was M. Sarraut, the representative of France, that the exercise of authority in banning the use of an abhorrent method of warfare was, under present conditions, scarcely practicable, and that whilst the agreement would serve to bind the Five Powers, it would not relieve nations from the necessity of preparing themselves against the use of gas by an unscrupulous enemy. We could not afford to ignore the lesson of April, 1915. The position thus reached by the Washington Conference is as satisfactory as could be expected. It is, in fact, all that was practicable, and it will be welcomed by all the Powers comprising the League of Nations. The issue now rests with Germany. But the moral effect of the action of the Conference will not be lost upon the world.

SIR DAVID PRAIN will shortly retire on account of age from the post of Director of the Royal Botanic Gardens, Kew, which he has held since 1905, and the First Lord of the Treasury has appointed as his successor Dr. A. W. Hill, who has been Assistant Director of the gardens for the last fourteen years, and was previously 'fellow' and 'dean' of King's College, Cambridge, and University lecturer in botany. Sir David Prain was born in 1857, and entered the Indian Medical Service in 1884, when he was almost at once seconded for service in the Botanic Garden at Sibpur, Calcutta, as curator of the herbarium, in 1898 succeeding the late Sir George King as superintendent. During this period his activities included the duties of professor of botany in the Calcutta Medical College, Director of the Botanical Survey of India, a trustee of the India Museum, and fellow of the Calcutta University. Upon the retirement of Sir William Thiselton-Dyer in 1905 from the directorship of the Royal Botanic Gardens at Kew, Sir David Prain was appointed his successor, and he has worthily maintained the high traditions of his post, the highest and most important of its kind in the British Empire. He has also been president of the Linnean Society of London (1916–19) and treasurer of the Royal Society since 1919, besides serving on numerous boards and committees of biological associations, where his well-balanced judgment and large experience have made him welcome. On entering on his duties at Kew he found them so exacting that his favourite botanic studies have been curtailed; with his coming release from official labours he will, no doubt, be able to devote himself to original work once more. Dr. Arthur Hill, who succeeds to the office of Director, has travelled in South America and tropical Africa; he has also been largely responsible for the laying-out of British cemeteries in France and Italy.

AN expedition, consisting of Prof. J. W. Gregory, of Glasgow University, and his son, Mr. Christopher J. Gregory, which has for its primary object the investigation of some features in the mountain structure of north-western Yunnan and western Szechuan, expects to leave for Burma at the end of March. The area is one of special geological and biological interest. It includes some mountains of which the height varies, according to the available information, from 20,000 to 25,000 ft.; and as these mountains occur in line with the Himalaya and the mountains south of Assam, it has been suggested that they represent a prolongation of the Himalaya and are continuous through China with the main mountain lines of north-eastern Asia. This view is opposed to the interpretation by von Richthofen that the mountains of this part of China belong to a pre-Himalayan system which they cross almost at right angles, and that the continuation of the Himalayan folds bends back through western Burma and is continued by the mountains on the southern edge of the Eastern Archipelago. It is hoped to obtain evidence for the solution of this problem, and also in reference to the remarkable parallelism of the three great rivers which discharge from south-eastern Tibet. The area is of biological interest in connection with the geographical distribution of the fauna and flora of south-eastern Asia. Some zoological and botanical collections will be made which it is hoped will be worked out in the British Museum of Natural History and in the India Museum, Calcutta. The expedition will travel *via* Rangoon, and hopes to start from Bhamo, near the north-western frontier of Burma, at the beginning of May.

THE council of the Geological Society has this year made the following awards:—Wollaston medal, Dr. A. Harker; Murchison medal, Dr. J. W. Evans; Lyell medal, Dr. C. Davison; Wollaston fund, Dr. L. J. Wills; Murchison fund, Mr. H. Bolton; and Lyell fund, Mr. A. Macconochie and Mr. D. Tait.

BEGINNING on January 26, we have arranged to issue a monthly supplement giving the titles of new books on science and technology published at home and abroad. Publishers have been invited to send us the titles of such additions to their catalogues, and it is hoped to make the lists an index to the chief scientific works issued. Any assistance which may be offered in order to make our lists complete will be welcomed.

AN Exchange telegram published in the *Daily Mail* on Monday announced that after a visit to Mount Kosciusko, the highest in Australia, Sir T. Edgeworth David and Profs. Skeats and Richards have confirmed the discovery in 1893 that the summit of that mountain was formerly covered by glaciers. The

new observations show that the glaciation was contemporary with the extinct giant wombat and other giant marsupials, which there is much evidence to show lived in south-eastern Australia when moister climatic conditions prevailed. The date of this glaciation is estimated by Sir Edgeworth David and his colleagues, according to the report, as 100,000 years ago.

At a meeting of the provisional council of the New Zealand Astronomical Society, held at the Hector Observatory, Wellington, on November 15 last, the following officers were elected:—*President:* Dr. C. E. Adams. *Vice-Presidents:* Hon. Sir Francis Bell, Prof. E. Marsden, Mr. T. Allison, and Dr. C. Munro Hector. *Secretary:* Prof. D. M. Y. Sommerville. *Treasurer:* Mr. C. G. G. Berry. *Editor:* Mr. A. C. Gifford. *Council:* Mr. J. C. Begg, Hon. Mr. Justice Chapman, Prof. C. Coleridge Farr, Mr. E. G. Hogg, Capt. G. S. Hooper, and Mr. J. T. Ward.

Under a provision of the Sundry Civil Act of March 4, 1921, Government Departments of the U.S.A. were required to suspend publication of all periodicals except those approved by Congress by December 1, 1921. A resolution empowering the Congressional Joint Committee on Printing to authorise the continuance or discontinuance of these periodicals, among them the *Journal of Agricultural Research*, passed the Senate, but did not come to a vote in the House before the adjournment of the last session of Congress. The *Journal of Agricultural Research* has, therefore, been suspended until its continuance is authorised by Congress.

On Tuesday next, January 17, at 3 o'clock, Dr. F. H. A. Marshall begins a course of two lectures at the Royal Institution on "Physiology as Applied to Agriculture"; on Thursday, January 19, Mr. Seton Gordon gives the first of two lectures on "Mountain Birds of Scotland" and "Sea-birds and Seals"; and on Saturday, January 21, Dr. Charles Macpherson, organist of St. Paul's Cathedral, commences a course of two lectures, with musical illustration, on "The Evolution of Organ Music." The Friday evening discourse on January 20 will be delivered by Sir James Dewar on "Soap Films and Molecular Forces," and on January 27 by Viscount Burnham on "Journalism."

The *Echo de Paris* is to be congratulated on the success of the subscription it raised to enable the octogenarian physicist Edouard Branly to continue his experimental work. Like many scientific men, Branly never sought commercial profits out of his discoveries, but the French public was unaware of the straits to which he had been reduced. It is now announced that the Branly Fund exceeds 200,000 francs (about 4000*l.*). Branly was the first to point out in 1890 that the electric resistance of a mass of metallic powder changed enormously when an electric spark took place in its neighbourhood. The resistance generally diminishes, but in a few cases—for instance, with peroxide of lead—it increases when the spark ensues. This was the principle of the earliest form of coherer which in the early days gave such an impetus to radiotelegraphy.

The first meeting of the Society of Telegraph Engineers was held on February 28, 1872, and the council of the Institution of Electrical Engineers (originally the Society of Telegraph Engineers) is arranging to commemorate the fiftieth anniversary of the meeting. On February 21 at 4 p.m., and on February 22 at 8.30 p.m., Prof. J. A. Fleming will deliver a popular lecture (to which admission is by ticket) on "Michael Faraday and the Foundations of Electrical Engineering." The annual dinner of the institution will be held on February 21, at 7 p.m., at the Hotel Cecil, and in the afternoon and evening of February 23 several members of the institution and others closely connected with the early development of electrical engineering will give short discourses on their reminiscences and experiences during the early history of the electricity supply industry. The speakers will deal both with matters of scientific and technical interest, and also with the effect of legislative action on the progress of the industry.

Influenza seems to be asserting itself with sufficient intensity to call for caution, especially on the part of the individual attacked, although at present the epidemic has not become sufficiently violent to cause alarm. The Registrar-General's weekly returns show that for the ninety-six great towns of England and Wales, including London, the deaths from influenza in the last six weeks have increased from 80 to 418, and in London alone the deaths from this cause have increased from 26 to 151. Fifty-nine per cent. of the deaths in London have occurred at ages above forty-five, whilst between twenty and forty-five years of age the deaths are 27 per cent., and below twenty years of age only 14 per cent. The age-incidence of death in the present epidemic differs from that in the severe epidemic of 1918–19, which for the most part attacked the able-bodied; the present attack has reverted to the incidence shown by the earlier epidemics after 1890. In the six weeks the deaths from pneumonia have nearly doubled, whilst deaths from bronchitis have remained fairly steady. With the abnormally mild weather in December the disease increased, which was a common feature with earlier epidemics, and it is to be hoped that the drop in temperature experienced in the early days of 1922 will lessen the severity of the attack.

Temperature in the past year was almost as abnormal as the rainfall, and November was the only month at Greenwich with the mean temperature below the average, whether compared with the normal for sixty-five years, 1841–1905, or with the normal for thirty-five years, 1881–1915, used by the Meteorological Office. The temperatures are given in Fahrenheit, and are chiefly from civil-day observations at Greenwich. The warmest month was July, with a mean of 68·5°, which is 4·8° above the average for sixty-five years, but both in January and October the excess of temperature was rather more than 7°. In November the

deficiency was 3·4°, but in December the excess was 4·7°. The mean temperature for the year was 52·8°, which is 2·7° in excess of the yearly normal; this is the highest mean annual temperature on record since 1841, the next highest being 52·0° in 1868 and 1911. In July the mean of the maximum, or highest day temperatures, was 81·6°; there have been only two years since 1841 with a higher mean maximum in July, 81·8° in 1859 and 82·0° in 1868. In January the mean maximum was 50·0°, and January, 1916, with a mean maximum 50·4°, is the only January with so high a mean maximum since 1841. The mean minimum in January is the highest on record. The mean for October, 57·6°, has never previously been equalled at Greenwich, and the high temperatures at the commencement of the month were most abnormal. For the British Isles generally the mean temperature for each month from January to April and in July, September, and October was above the normal in all districts, and in England and Wales there was an excess every month from January to October, except for August, in North-West England, where it was in agreement with the average. The mean excess of temperature for all districts in the British Isles, except the North of Scotland and the English Channel, for the ten months, January to October, was 2·6°; in January the excess was 5·2°, in July 4·3°, and in October 6·9°.

THE United States National Museum (Proc., vol. 59) has published a descriptive catalogue of its collection of Buddhist art, compiled by Mr. I. M. Casanowicz. The collection is large, but it does not seem to possess many objects valuable for their antiquity or artistic beauty, the best being a Japanese bronze statue of Buddha, dated 1648. There is also a good collection of rosaries, examples of magical appliances, and objects used in worship. Mr. Casanowicz has given an interesting introduction on Buddhism and its developments. The pamphlet deserves the attention of all those who are interested in the subject.

THE Journal of the Royal Anthropological Institute, part 1, for 1921, prints the presidential address delivered by Sir Everard im Thurn, which gives an interesting historical sketch of the relations between Europeans and the natives of the South Sea Islands after they were discovered. The state of savagery in which the natives were found does not imply fierceness: they were wild and uncontrolled in so far as they had not been subjected to what we call "civilisation," but they had developed for themselves a certain degree—in many cases a very high degree—of culture. The writer sums up his conclusions thus: "The Islanders were, when Europeans first went among them, not a savage, *i.e.* a fierce race, but were highly cultured, if self-cultured, people, but entirely uncivilised; they were at first puzzled what to make of the civilised, or quasi-civilised, people who went among them, and they only became repellent when they were habitually injured by their visitors."

THE educational work of the Commercial Museum of Philadelphia, as decribed by its curator, Mr. C. R. Toothaker, in Bulletin No. 13 (1920) of the United States Bureau of Education, is partly for business men and partly for the rising generation. Aid is given to the former by the foreign trade bureau of the museum, which publishes two journals, one of them in separate Spanish and English editions. Schools are provided for by official guidance to a study of the exhibits, daily lectures to visiting classes on subjects chosen by the school-teachers, lectures to teachers and others, loan lectures with lantern-slides sent to schools outside Philadelphia, and school collections given, not lent, to the schools of Pennsylvania. Full details of these last are given in this well-illustrated pamphlet.

THE recently published annual report of the Yorkshire Philosophical Society for 1920 reminds us that with 1922 the society reaches its centenary. It sprang from the suggestion that a museum should be founded to receive the bones just discovered in the Kirkdale Cave. Famous men have been connected with the society. It was the parent of the British Association in 1831 and of the Museums Association in 1888, while in local archæology it has done, and is doing, admirable work. Under the present keeper of the museum, Dr. Collinge, the zoological collections are being put in good order, and Mr. J. Hetherton has lately placed a wood of considerable area at the disposal of the society for use as a bird sanctuary. The geological collections contain many valuable fossils, and the report concludes with "Notes on the Later Tertiary Invertebrata" of these islands by the veteran Mr. Alfred Bell; most of the species are in the society's museum.

THE last annual report of the National Museum of Wales records some advance in completing the western section of the new building. The reserve galleries and basement are now occupied, and the keepers of art, botany, and zoology, with their staffs, are installed in their new quarters, while the department of geology has temporary accommodation. These departments are, however, hindered by lack of museum furniture, for which the available funds are insufficient. The museum worthily acts up to its title of "National," co-operating with all relevant bodies in the Principality, with mine-owners, quarry-owners, and industrial firms, and in particular with the faunistic survey of the County of Glamorgan and the local education authorities. A number of accessions of local interest, as well as many others, are recorded by all the departments. It is not in man to command financial support, but Dr. Hoyle and his able staff undoubtedly deserve it.

THE geological model of the Bristol district which has recently been placed in the Bristol Museum and Art Gallery depicts the relief and the geological outcrops of the district on a horizontal scale of 3 in. to 1 mile and a vertical scale of 1 in. to 500 ft. An explanatory guide to this relief map has been prepared by Prof. S. H. Reynolds. The pamphlet includes a description of the present land surface and a sketch of the geological history designed to explain the

origin of the chief physical features. A short account of the distribution of the geological formations is also given, and this is followed by a section which describes the roads and railways of the district in their relation to the surface relief. The pamphlet should prove indispensable to those students and teachers of geography and geology who have access to the model.

FROM the "Report on the Zoological Service for the Year 1920" we learn that the Giza Zoological Gardens have been restored to their pre-war condition of cleanliness. The number of visitors during that year was greater than in any previous year. A special feature of these gardens is the thousands of birds in a state of complete liberty which frequent the grounds, and we are glad to note that the numbers of cattle egrets, little egrets, and hoopoes which have nested there are increasing. The new building of the Giza Zoological Museum was opened in 1920. Lack of space and insufficiency of staff, however, will prevent the development of a general natural history museum. The insect collections have already been transferred to the Ministry of Agriculture and the marine invertebrates to the Sultana Hydrobiological Institute. The Zoological Service of Egypt is doing a useful work in the preservation of the natural fauna of the country both by protecting game and nesting birds and by controlling beasts of prey. Special success has attended its efforts to protect birds from the birdlimers, to preserve the breeding colonies of the cattle egrets, and to keep down the number of jackals.

AN interesting addition to the flowering plants of the British flora is announced in the November issue of the *Naturalist*. Mr. R. W. Butcher found *Tillaea aquatica* at Adel, near Leeds, in September, where it was the dominant plant growing in abundance on the drying-up mud on the margin of a pool. Dr. G. C. Druce has examined the plant, and agrees that it is probably a true native species or one brought there by purely natural means. The typical plant is known from Germany, and a sub-species also occurs in France and Italy.

THE December issue of the Journal of the Franklin Institute contains a paper by Mr. Enoch Karrer, of the Nela Research Laboratories, Cleveland, Ohio, on the shape assumed by a deformable body immersed in a moving fluid. The author's attention was directed to the subject by the behaviour of a drop of mercury just above a constriction in a vertical glass tube up which a current of gas was flowing. As the speed of the gas was increased the drop was raised above the constriction and assumed a slightly egg-shaped form with its larger end downwards. With increase of speed it elongated, keeping its larger end downwards, and finally a small drop detached itself from its upper end. From these observations the author concludes that a deformable body in a moving fluid assumes a stream-line shape. He supports his conclusion by figures of snow drifts and snow bosses from Cornish's "Waves of Sand and Snow," of egg-shaped boulders with their long axes in the direction of the wind and their big ends up-wind, and by the shapes of moths, birds, and fishes. By analogy with "geotropism"—the adjustment of organisms under gravity—the author proposes to name this new principle "rheotropism."

THE Meteorological Office of the Air Ministry has recently issued as No. 18 of the Geophysical Memoirs a memoir by Mr. W. H. Dines on observations on radiation from the sky and an attempt to determine the atmospheric constant of radiation. The measurements were made at Benson during 1920. The sky was divided into six zones of 15° width, and the radiation was taken at the altitudes corresponding to the mean altitude of the zones. The final form of instrument used was a thermopile of copper-eureka junctions designed by L. F. Richardson. The observations were made at, or a little after, sunset, and are classified under "clear sky," "overcast sky," and "very clouded sky." By suitable methods the amount of radiation received from each zone on a horizontal surface at ground-level is calculated, and the final results show that the average daily supply of heat from the atmosphere throughout the year falling on one square centimetre in the South of England on clear days is 506 gram calories. For fully clouded skies the value is about 700, with a general mean for all days of about 600. For a mean temperature of 50° F. the outward radiation from the earth is 711 gram calories, so that the net or effective radiation for a clear sky is rather more than 200 gram calories. This is 25 per cent. less than the values usually given, which, however, have been mostly obtained at much greater altitudes than Benson (186 ft. above sea-level).

THE commercial transmission of power conveyed electrically by overhead wires has made the study of lightning arresters of great importance. In places where thunderstorms are violent, such as in certain parts of South Africa or where the lines have to traverse mountainous regions, the use of efficient lightning arresters is a necessity. In this connection the papers published in the *General Electric Review* for November and December last by J. L. R. Hayden and N. A. Lougee are of value. The object of lightning arresters is to afford protection against sudden rushes of electricity at high potential in the lines due to atmospheric disturbances. To get similar electric surges in the laboratory they build up a battery of glass-plate condensers which by means of the kenotron (a two-electrode thermionic valve for rectifying currents of high voltage) can be charged by an alternating-current transformer to 30,000 volts; 200 of these condensers are used, which can be connected in parallel or in two groups of 100 in parallel or in four groups of 50 in parallel. When they are all in parallel the capacity is 1·6 microfarads, and at 30 kilovolts the energy stored is 720 joules. With the arrangements they used they got a maximum discharge of 9500 amperes at 120,000 volts, the discharge frequency being 126,000. Three types of lightning arrester were examined: (1) the horn type with resistance in series, (2) the electrolytic type, and (3) the multigap type. Their results prove that the

resistance in the horn type was very detrimental, that the electrolytic type was very efficient, but that its expense limited its use, and that the multigap type was an efficient and cheap type of lightning arrester.

MESSRS. LONGMANS AND CO. have in the press "Modern Practice in Heat Engines," by T. Petrie, which is intended to form a companion to the late W. Inchley's "Theory of Heat Engines." It deals with the subject of power from heat engines as a whole, and attempts to show how far theory may be applied to the design of modern types. The book is divided into three sections, steam boilers, steam prime movers, and internal-combustion engines, each section containing a descriptive chapter on the latest types with sectional illustrations which, in many cases, approximate to working drawings. Another book announced by the same publishers is a translation, by Dr. J. S. Thomas, of Prof. A. Smits's "The Theory of Allotropy."

MR. F. EDWARDS, 83 High Street, Marylebone, W.1, has just issued a Hand-list (No. 422) of Biographies, Autobiographies, Diaries, Journals, Correspondence, etc., of Famous Men and Women. Many men of science are represented in the catalogue.

MR. E. MARSDEN, one of the authors of "Geography for Junior Classes," of which a short notice appeared in NATURE of December 22 last, writes to point out that the phrase "lines and belts of equal heat," which the reviewer remarked "is bad anywhere," occurs also in Geikie's "Elementary Lessons in Physical Geography" and in the revised edition of Huxley's "Physiography." The use of the phrase in other books does not, however, alter the reviewer's objection to it.

IN an article entitled "Fisheries Biology" in NATURE of December 29, p. 585, it is stated that "the spur-dog and nurse-hound are viviparous." Mr. E. Ford writes to inform us that the term "nurse-hound" is applied at Plymouth to *Scyliorhinus stellaris*, which is not viviparous. We understand from the writer of our article that confusion has arisen from the fact that the name "nurse-hound" is also used by fishermen in his district to refer to *Mustelus vulgaris*, which is viviparous.

Our Astronomical Column.

THE SHOWER OF JANUARY METEORS.—A rather abundant display of these objects was observed on the night following January 3. Mr. W. F. Denning writes as follows:—At Bristol the early part of the evening was clear, and between 5.40 and 6.50 p.m. meteors appeared at the rate of thirty per hour. Clouds, wind, and sleet then interrupted watching until about 9 p.m., when the atmosphere again cleared, and the remainder of the night was splendidly favourable for observation. The shower, however, declined in numbers strikingly, for in the two or three hours preceding midnight the hourly rate of apparition was only twelve, and there was a further falling off as the night progressed. The radiant point was at $232°+53°$. Large meteors were frequent, and a number of them have been recorded at several stations. Miss A. Grace Cook witnessed the event from Stowmarket and saw a considerable number of meteors on the two nights January 2 and 3. She registered a fair proportion of large ones, and found the maximum intensity occurred in the early part of January 3. The radiant was at $231°+53°$.

SPECTRAL EVIDENCE OF A PERSISTENT AURORA.—Bulletin No. 76 (vol. 3, No. 1) of the Lowell Observatory, contains an interesting account by Mr. V. M. Slipher of his successful attempts to show that the aurora is always present in the night sky. Working on the fact that the spectrum of the aurora consists of certain emissions, of which one in the yellow-green is so intense relatively as to contain a considerable portion of the total auroral light, he finds it possible to record this line with an exposure of only a few hours, even if there be moonlight. The instrument he employs is a spectrograph with a 66 degree flint glass prism, and a Dallmeyer lens of f/1·9 ratio, the photographic plates being of the Cramer isochromatic brand. This spectrograph was usually simply pointed to the sky, but in some cases a small objective was placed in front of it. All the exposures he made showed the characteristic auroral line, thus proving the existence of auroral illumination, persistent or permanent at least over the period covered by his series of plates, which commenced in the year 1915. The two plates which accompany his paper show the auroral line clearly on both moonlight and moonless nights.

MOVEMENTS IN SPIRAL NEBULÆ.—Dr. Jeans exhibited at the November meeting of the Royal Astronomical Society some slides sent by Dr. Van Maanen, showing movements in the spirals M 101 and M 33. He demonstrated that the only tenable motions that would conserve the equiangular spiral forms were compounded of pure rotation and motion along the arms. The latter type greatly predominates in these nebulæ, and the indicated times of revolution round the nucleus are 85,000 years and 160,000 years respectively. Since only two whorls of nebulosity can be traced, implying a duration of a third of a million years, it was conjectured that the outer whorls may have become invisible, just as the puffs of steam from a locomotive soon dissipate. By the combination of observed shifts with line-of-sight velocities, a distance of 2000 parsecs was deduced for M 33. This would be fatal to the island-universe hypothesis, since it would place the object well within the confines of the galaxy. There have been fairly regular oscillations of opinion on the hypothesis, the prevailing view at the Royal Astronomical Society's meeting being hostile to it.

A BRIGHT FIREBALL.—Mr. G. E. Sutcliffe writes from Shahpur, Ahmedabad, India, that on November 22 last, at about 6 a.m., when gazing towards the Southern Cross, he saw a large fireball emerging from the horizon. The object appeared to be approaching him and to move more slowly than ordinary shooting stars. It became intensely brilliant. Its motion was directed nearly from south to north, and it passed a little to the east of his zenith. During the early part of its track the fireball was globular in shape, and it had a distinct tail like a comet.

A Notable Exhibition of Physical Apparatus.

THE Physical Society of London and the Optical Society held their twelfth exhibition of electrical, optical, and other apparatus at the Imperial College of Science on January 4 and 5. As in past years, the exhibition rooms were crowded with apparatus and visitors; the latter were so numerous that the exhibition became a continuous one instead of closing between 6 and 7 p.m. each day. The display of scientific apparatus was probably the finest ever seen in this country, and the quality and finish of the instruments left little to be desired. There were many instruments of novel design, but attention can be directed to a few only.

A quite novel exhibit was an optical sonometer by the firm of Hilger, Ltd. This is designed to record the pressure variations caused by sound-waves, and should prove invaluable to workers in acoustics. The most novel feature is the diaphragm, which is a film having a thickness of a fraction of a wave-length of light, and is silvered or gilded on one side by a cathode process. The sound-wave under examination is received by a horn, and causes the diaphragm, and ultimately a beam of light, to vibrate. An intense point image is produced, and a photographic record can be obtained on a rotating film. The vowel sounds and all kinds of acoustic disturbances may thus be analysed. In another arrangement, which is excellently adapted for demonstration purposes, a rotating band with white lines on a dark ground is illuminated by a line image from the diaphragm. By adjustment of the speed of rotation stationary wave effects are obtained.

The episcope, shown by Newton and Co., is a marked improvement on forms previously seen, and should come into more general use for the projection on screens of opaque objects. The present instrument is of beautiful design, and with its two 2000-candle-power lamps very bright pictures of opaque objects may be projected on a screen 5 metres or more away. In large teaching institutions this instrument could be put to many uses.

The Marconi Co. exhibited its new automatic alarm which responds to the wireless call of a ship in distress. In the present form of instrument the distress call must consist of three dashes, each of four seconds' duration, the dashes being separated by one-second intervals. By means of an amplifying circuit, plungers working in dash-pots are caused to respond to the four-second impulses, and after a series of three such impulses a warning signal occurs. If the impulses last for more or less than four seconds, subject to a tolerance of about half a second, the circuit necessary to operate the alarm is not completed. The demonstrations given were accompanied by artificial atmospherics and continuous wireless reception, and were remarkably successful.

Creed and Co. again showed their system of high-speed automatic printing of wireless messages, but at an increased speed of reception. Signals from Chelmsford were regularly received, the Morse code perforations in a paper strip being transposed into Roman characters by an automatic printer. The speed ranges from 50 to 200 words per minute. While the writer was present a message was received from the Marconi Co. conveying its wishes for the success of the exhibition. The receiving aerial appeared to be a very insignificant affair, and many visitors marvelled at the present efficiency of triode-valve amplifiers.

A novel weather foreteller, the design of which is due to Mr. Kitchen, was shown by Negretti and Zambra. The instrument is based on meteorological data extending over many years. The forecast for twelve hours appears in a small window in the instrument after the barometer and wind-scales have been set to correspond to the conditions existing at the time. It would be of interest to have a record over six months of "predictions" and "happenings."

Tucker's hot-wire resonator microphone was shown by H. W. Sullivan. The microphone consists of a heated wire in the neck of a resonator and is insensitive to all but the particular sound frequency which it is desired to receive. The hot wire is cooled by the oscillating air-currents at the resonant frequency, and the change in the resistance of the wire is caused to operate an amplifier.

The Cambridge and Paul Instrument Co. exhibited a novel temperature regulator, in which the current from a thermo-couple in a furnace passes through a millivoltmeter, at the end of the pointer of which is a light thermo-couple in series with a moving coil relay. When the furnace is at the temperature which it is desired to maintain, the light thermo-couple is brought, by the movement of the pointer, into close juxtaposition to a small heated body. A current is thus generated which operates the relay and indirectly controls the current in the furnace. The instrument exhibited controlled a small electric furnace at about 700° C. within about 5° C.

The Edison Swan Co. showed a 10,000-candle-power pointolite lamp of ingenious construction; many visitors remarked on the skill required to seal leads into glass for the passage of a current of 40 amperes. The firm of Ilford, Ltd., showed a new and improved colourless filter which completely cuts off ultraviolet rays. It is claimed to be much superior to the usual æsculin filter, and is known as "Q" (acetaminoquinoline). The Davison microtelescope, while not new, attracted considerable attention, and users of the microscope admired a new 25-watt mercury vapour lamp made by Chas. Baker. Shotter's integrator for water-flow meters was shown by H. Tinsley; it represents a new application of the Wheatstone bridge. Among precise measuring instruments the Campbell fundamental standard of mutual inductance (shown by R. W. Paul) must be mentioned, and also the "Talymin," by Taylor, Taylor and Hobson, which determines within small limits of error the outside diameters of small manufactured parts.

An experimental lecture on "The Johnsen-Rahbek Electrostatic Telephone and its Predecessors" was given on both days by Mr. A. A. Campbell Swinton. Another lecture on "Radium: Its Application in Peace and War" was delivered by Mr. F. Harrison Glew, and a third lecture on "The Employment of Coarse Wire Gratings in Astronomy" was given by Sir Frank W. Dyson. These lectures were attended by large audiences, and were highly appreciated.

Science in Secondary Schools

THE twenty-second annual general meeting of the Science Masters' Association, which was held last week at the Imperial College of Science, was presided over by the Master of Balliol. His address on the subject of the relationship of history and science will long be remembered by those who were fortunate enough to hear it for the genial humour and literary grace with which he defined the position and importance of these complementary branches of learning.

The association has been growing steadily in size and influence, and in recent years more than one important development in scientific education has taken its origin in the deliberations of its assemblies. Unless we are mistaken, we may expect to see, as a result of this meeting, a serious endeavour to introduce the fundamental principles of physical chemistry in the early stages of science teaching. Brig.-Gen. H. Hartley made this suggestion both in the interests of intellectual economy and of clear thinking. It was time, he said, that they tried to simplify for their pupils the memorising of the ever-growing mass of known chemical facts by showing them at the outset how these are co-ordinated; thus would pure memory work be reduced, being replaced by reasoning which was well within the powers of the students. Prof. J. C. Philip, who, in common with other speakers, strongly supported this view, emphasised the importance of introducing the physico-chemical ideas into the ordinary chemistry courses in preference to teaching physical chemistry as a separate subject at the start. It was further explained that neither expensive apparatus nor extraordinary mathematical ability on the part of the pupils is necessary in the early stages of such instruction. It is rare to find in a big gathering such unanimity of opinion that a change of this sort in traditional teaching is both desirable and possible. In all probability more will be heard of it.

During the course of the meetings, which extended over two days, there were several other discussions, of which the following general impressions were obtained:—First, as regards the teaching of dynamics; this is still, with rare exceptions, in a chaotic condition in our schools. The subject is often left in the hands of mathematical masters, and divorced from the teaching of science. In any case, the presentation of mechanics is usually far too formal, with the result that it makes little appeal to beginners.

Geography seems to be in a better way. Some attempt was made at the meeting to define, perhaps to limit, the activities of the specialist teacher of geography. But it was fairly generally agreed that he had made good, and that science has much to gain and nothing to lose by the growing importance which is being attached to the modern geographer's methods.

Major E. R. Thomas, in opening a discussion on post-certificate science for the non-specialist, spoke of the importance of emphasising the cultural value of the subject. For this class of student especially it is desirable to bring into prominence the historical, biographical, and philosophical aspects of the subject. This kind of teaching is now being widely adopted, and is already being reflected in the work of those who are specialising in science. For many years the association has done its utmost to save the youth of the country from the materialistic tendencies which may follow from the study of natural science if it is narrowly conceived and inadequately expounded.

The discussions will be fully reported in the next issue of the *School Science Review*, which Mr. G. H. J. Adlam will continue to edit. During the coming year Sir Ernest Rutherford will be the president of the association, of which Major V. S. Bryant (St. Piran's School, Maidenhead) and Major C. E. Sladden (Eton College) are the secretaries.

The annual meeting of the Association of Science Teachers was held at University College, London, on January 3 last. At a business meeting in the morning the following resolution was unanimously passed:—"That this meeting of the Association of Science Teachers deeply regrets the action of the University of Cambridge, in that, alone among British universities, it continues to exclude women from membership. The association believes that such exclusion must be prejudicial to the higher education of women in general, and especially in natural science, for the study of which Cambridge can offer exceptional advantages."

A very useful discussion on practical examinations in science, initiated by a resolution concerning general elementary science as a subject in the General School Examination of the University of London, was made more valuable by the presence of Mr. Lea, representing the University. The general sense of the meeting was in favour of the retention, or even extension, of practical tests in science as a part of the First Examination.

In the afternoon Dr. Winifred Brenchley, of the Rothamsted Experimental Station, lectured on "The Effects of Competition on Plant-life." She pointed out that competition is prevalent both above and below ground. In the soil the deficiency of any constituent of plant-food may become a limiting factor in the growth of the plant, and the elements which act most frequently in this way are nitrogen and phosphorus, and to a less extent potassium. Tests on this point are made by pot-cultures, in which the composition of the soil can be controlled. By such tests it can be shown that with scanty nourishment one plant will increase as much in dry weight as a number of plants crowded into the same amount of soil.

Above ground the limiting factor is light, leaf mosaics and other leaf arrangements being an adaptation to this condition. The effect of light is not always obvious, as crowded plants are taller than "spaced" ones, but a comparison of dry weights shows that the "spaced" plant increases 50 per cent. more than the crowded one.

Plants are adapted to live in communities on a limited amount of soil by varying root depth, *e.g.* during the drought of last summer bird's foot trefoil flourished exceedingly because it had deep roots. Cultivated plants cannot exist at all in competition with weeds. Investigations undertaken at Rothamsted have shown the extraordinary vitality of weed-seeds, and work is now proceeding on a survey of weeds of various districts. In this matter Dr. Brenchley seeks to enlist the help of schools in various parts of the country, and will be glad to send details as to the data required to anyone who can help in this way.

Problems of Animal Breeding.

An interesting series of articles on research in animal breeding appeared in the April–July issues of the *Journal of the Ministry of Agriculture*. In the first two papers the author, Prof. R. C. Punnett, traces the results of crossing red with black and polled with horned cattle, and in this way illustrates the Mendelian principles underlying all breeding methods. Mendelism not only enables the breeder to understand why red calves sometimes appear even in the most highly pedigreed Aberdeen, Angus, or Holstein cattle, but it also supplies the knowledge which can be used to prevent their ever appearing again. The factors with which breeders are concerned are rarely as simple as in the black-red case of cattle, where the possibilities form a simple alternative pair, and in both cases one of the characters is completely dominant to the other, black being dominant to red and polled to horned. A more

complex example is given by crossing black polled with red horned cattle, which in the first generation yields all black polled animals, but in the second generation a very mixed progeny arises. If the factors for the black-red and the polled-horned pairs are transmitted in the same manner, but *independently of one another*, then the second generation will consist of four classes: black-polled, black-horned, red-polled, and red-horned in the ratio of 9:3:3:1. This ratio has not been verified on a comprehensive scale for the cattle cross, but it has been worked out in all details in several cases for smaller animals. That horned-blacks and polled-reds appear in the second filial generation means that there has been a "break up" of the parental types, and the new classes arise through re-combination of the two pairs of factors in which the original parents differed.

Many of the characters of animals owe their manifestation to the presence of one or other definite factor transmitted according to a definite scheme. If these factors are not divisible under normal conditions they must be transmitted through the germ-cells as definite entities producing their full effect in each successive generation. Therefore, if these factors are relatively permanent, and follow a fixed scheme of distribution in heredity, it is obvious that the characters of living things can be brought under accurate control by the breeder. This factorial theory of heredity has been tested and proved to hold good in a large number of cases, and the problem now engaging the attention of research workers at Cambridge is to find whether it can be applied to those cases where at first sight there appears no suggestion of clear-cut alternative pairs of characters.

The last two papers of the series under notice deal with some of the experiments carried out on these lines. One of the most extensive analyses was designed to investigate the inheritance of weight in poultry. Two standard breeds were chosen; for the larger bird the Gold-pencilled Hamburgh, and for the smaller one the Silver Sebright Bantam, the latter being, roughly, three-fifths of the weight of the former. The first-cross birds were intermediate in size, but in the second generation there was a very wide variation. The majority of birds were between the weights of the original parental birds, but a few were larger than the Hamburgh, while a few were smaller than the Sebright. Nilsson-Ehle, working on wheat and oats, was the first to give an explanation of such cases, and the closeness with which the theory fitted his results left little doubt of its being a true interpretation. Essentially, his theory is that a similar effect may be brought about by more than one factor, though such factors are independently transmitted. Accordingly, if there are several similar factors, A, B, C, D, etc., which influence the weight of poultry, then a bird possessing none of these factors will be the smallest type. When it contains A, it will be rather larger; when it contains A and B, it will be larger again, and so on until the largest bird is reached which contains the full collection of the weight factors.

This theory was found to cover all the observed facts, and although it is not suggested that weight is dependent solely upon such factors, yet it seems probable that even such complicated characters can be interpreted in terms of definite factors. On the other hand, very different results were obtained in experiments on rabbits, where the large Flemish was crossed with the small Polish rabbit. In this case the F_2 generation contained no animals at all approaching the size of the original Flemish, and no explanation of this can at present be offered. Further experiments on rabbits were concerned with the inheritance of coat patterns, and the analysis of the continuous series from self-colour to almost white provided an interpretation in terms of the factorial theory.

Another interesting series of analyses dealt with the peculiar form of inheritance known as sex-linked heredity. This can be illustrated by the Hamburgh-Sebright cross used for the weight experiments. The Hamburgh was a gold-pencilled and the Sebright a silver, and the experimental work showed that silver and gold form an alternative pair, silver being a simple dominant to gold, but in the hen the transmission of the factor for silver is sex-linked. The silver hen is never pure for the silver factor; half of her eggs are "silver" and half are "gold"; moreover, she transmits the silver factors to her male-producing eggs and the gold to her female-producing eggs. A large number of birds have been bred from the mating of silver hen and gold cockerel, but there has not been one exception to the rule that the cockerels all come silver and the pullets all gold. This sex-linked type of inheritance is found in several other characters in poultry, and it may prove of economic importance, for by making use of suitable crosses the breeder of poultry for egg-production can be sure of rearing nothing but pullets through the earlier, and more costly, stages.

Further experiments dealt with the inheritance by cocks of henny feathering, while others were concerned with the characters of egg-colour and broodiness in poultry. These had to be curtailed considerably owing to war conditions, although some interesting results were obtained.

Although all these analyses may prove to be of economic value, yet it must be remembered that the "main object of the work at Cambridge is the elucidation of the principles that underlie the phenomena of heredity," and when these have been revealed the application can be left to those who will derive profit from it.

A Petrological Microscope.

WE have received for examination from Messrs. R. and J. Beck an example of their "Standard London Petrological Microscope," which they have recently designed for the use of students. It embodies some of the recommendations of a committee of the British Science Guild, which carefully considered the subject (Journal of the British Science Guild, November, 1916, pp. 28–30). The microscope, which is strongly built and stands firmly, has the following distinctive features:

The analyser is a form of the Abbe prism, devised by Mr. E. M. Nelson. It is placed immediately below the upper lens of the ocular, and slides laterally in and out of position. This arrangement, while it does not appreciably contract the field, has the advantage that it allows a quartz wedge to be inserted between the nicols in the focus of the ocular, with the result that the colour bands are sharply defined, as is also the dark band indicating the position of compensation. It is stated that in certain circumstances a faint second image of the cross wires can be seen, but it is scarcely noticeable, and causes

no inconvenience. The analyser can be rotated about the axis of the microscope, and is provided with clicks in the positions of crossed and parallel nicols. There is an arrangement by which it can be rotated alternately through small equal angles in opposite directions, from the position of crossed nicols, thus affording an accurate means of determining whether the exact position of extinction of a mineral has been arrived at.

The "directions-image," showing interference figures, is obtained, not by the insertion of a "Bertrand" lens in the tube, but by placing a "Becke" lens over the ocular. This is decidedly preferable as it enables the optical effects of a small crystal or twin lamella to be isolated by first placing a diaphragm, with a hole of suitable dimensions, in the focus of the ocular, so as to hide everything except the object to be studied, and then putting the Becke lens into position. The diaphragm is so constructed that it allows of the insertion of a gypsum plate or quartz wedge immediately above it.

These arrangements render it unnecessary to cut into the tube of the microscope to allow of the introduction of the analyser and the Bertrand lens. This means less labour in construction, and therefore less cost.

It may be added that the upper lens of the ocular is adjustable, so as to admit of its being exactly focussed on the quartz wedge, the cross wires, or the perforation in the diaphragm, and there is also an adjustment of the Becke lens for the purpose of focussing the interference figures.

The polariser is conveniently placed in a swing-out below the stage. It has a slot immediately below it for the insertion of a diaphragm with a small circular or linear aperture for comparing the refractive indices of adjoining minerals by the Becke method, and other purposes.

When it is required to insert the condenser it is slid up into a cylindrical fitting in the stage. This is not very convenient, but we are informed that the firm is arranging to substitute a swing-out attachment, which it is believed will prove in every way satisfactory.

An interesting feature is the Sloan objective changer, which takes only two or three seconds to operate. Each objective is attached to a collar by means of two screws. When these are once correctly adjusted, the objective will always be found to be correctly centred immediately on insertion.

Among the accessories is a quartz wedge cemented to a gypsum plate, and graduated in intervals of fifty micromillimetres of relative retardation. This should render unnecessary the quarter-wave mica and Klein's plate, which are, however, still retained in the list of accessories.

It may be suggested that the fine adjustment should be provided with a milled head graduated to five microns on its circumference, even if it were only approximately accurate.

Archæology in Mexico.

AT a meeting of the Royal Anthropological Institute on November 22 Mrs. Zelia Nuttall gave an account of recent archæological investigations in Mexico. As an introduction to her report Mrs. Nuttall referred briefly to the fact that after a period of quiescence of some centuries the great volcano Popocatapetl had again become active in 1920, and that its activity still continued.

During the last decade evidence that great volcanic disturbances had taken place at long intervals has been forthcoming. Two distinct types of figurines have been found in conditions which indicate that the topography of the valley has been changed and its inhabitants destroyed by great catastrophes antedating the arrival of the Nahuas or Aztecs.

Of these figurines the first, provisionally distinguished as the sub-gravel type, was brought to Mrs. Nuttall's notice in 1909, when specimens were offered for sale by Indians, and she herself discovered an example *in situ* under a gravel bed at Atzacapotzalco. They were delicately fashioned of fine clay, with slender bodies, long faces, smooth-hanging hair, some wearing chaplets. All presented a worn and polished surface. In the Valley of Mexico the gravel beds extend under the lava flow at the base of the extinct volcano Ajusco.

Under the lava bed, to which Dr. Tempest Anderson assigns an age of at least 20,000 years, Mrs. Nuttall in 1908, and afterwards Señor Gamio, head of the Department of Archæology of Mexico, have discovered a second type of figurine, to which the name "sub-lava type" has been given. This type is characterised by turbans and caps, evidently of fine stuffs or fur, and decorated with circular ornaments of stone or shell. They indicate that the southern part of the valley was inhabited by a race totally distinct from that of the "sub-gravel type" and the Aztec. The distribution of the clay figurines is now under investigation. They have been traced as far as Guatemala.

Mrs. Nuttall also described the results of recent excavations at Teotihuacan, during which a small pyramid was opened up and reconstructed by Señor Gamio. A tunnel pierced at the height of 35 ft. to the centre of the pyramid revealed that it had been formed of mud filled with innumerable fragments of pottery vessels which had prevented the mud from cracking when it baked in the sun. A remarkable discovery was that of the remains of the ancient pyramid temple with a wonderful sculptured frieze which had been partly destroyed and then concealed by another terraced pyramid temple built in front. The sculptured serpents' heads and the masks of the water-god Tlaloc are of a form hitherto unknown. Associated with them are sculptured shells, principally the conch shell and the pecten or pearl shell. Not only is it remarkable that sea-shells should be represented in sculpture in the heart of the continent, but the association of the water-god with the ocean is entirely new.

In the discussion which followed Mrs. Nuttall's paper, Mr. Maudslay expressed the hope that it might be possible before long, by the elaboration of a system of stratification, to date Mexican antiquities. As Mexico appeared to have been untouched by outside influence, the study of its antiquities afforded evidence of the highest value for the study of the development of the human mind acting by itself. Mr. T. A. Joyce emphasised the importance of the evidence relating to the figurines, and pointed out that the British Museum had acquired a figurine of similar technique from Ecuador. Prof. Elliot Smith expressed the opinion that, contrary to what had been stated by Mr. Maudslay, Mexican antiquities showed clear evidence of influence from outside, and in particular from Asia. Mrs. Nuttall's work showed that this culture must have crossed the Pacific.

The Treasury Grant to Universities.

WE have already referred on several occasions to the proposed reduction, from 1,500,000*l.* to 1,200,000*l.*, in the Treasury grant-in-aid of university education for the coming financial year 1922–23. A memorandum, in which the dangers of reducing the grants and the rightful claims of the universities are ably stated, signed by the Vice-Chancellors of the Universities of Birmingham, Durham, Leeds, Liverpool, Manchester, and Sheffield, has been forwarded to the Prime Minister. The document has also received the approbation of the Vice-Chancellors of the Universities of Oxford, Cambridge London, Bristol, Glasgow, Aberdeen, and Wales. As we have repeatedly pointed out, the universities are the chief centres of research; they advance science and, to regard the matter from the purely commercial side, they have unquestionably added millions to the national wealth by the way in which they have enriched industry and commerce. In return for their great services, and in order to continue to be able to give such service, they are asking the Government to assist in maintaining their relatively modest financial resources. Encouraged by the hope that funds raised locally would be met by a corresponding increase in Treasury grants, great efforts have been made and every form of self-help employed; severe economy has been practised in structural expenditure and in the maintenance and equipment of laboratories; students' fees have been increased so that one-third of the total income of the universities of the North is derived from this source; private benefactors have given 1,175,000*l.* in response to urgent appeals; and local authorities have increased their grants to these universities from 74,268*l.* in 1913–14 to 135,868*l.*

In spite of this effort and the proportion of the Treasury grant allocated to the universities of the North of England, heavy losses were sustained in the working of the last academic year. It is therefore considered that with a curtailment of the existing grant the efficiency of the universities will be seriously impaired. In other countries, with which Britain must come into competition, efforts are being made to increase the resources of the universities. It is only necessary in this connection to recall the case of McGill University of Montreal, which has recently received sums amounting to seven million dollars in gifts from private benefactors and subsidies from public funds. The universities are admittedly of prime national importance, and when their resources, exploited to the uttermost, are insufficient for the maintenance of efficiency and vigour, it becomes a national duty to provide the necessary additional funds.

The Royal Academy Winter Exhibition.

THE exhibition which opened this week of works by recently deceased members of the Royal Academy affords an opportunity of comparing the pictures which have been exhibited at different dates during the past fifty years with those of the present time as shown year by year at the summer exhibitions. Even a rapid tour round the galleries shows that, so far as landscapes and Nature studies are concerned, the past can well bear comparison with the present, the number of unsatisfactory representations of Nature in the present exhibition being remarkably few. This does not prove that such pictures were not exhibited fifty years ago; it may indicate only that the Selection Committee in making choice has avoided pictures of that type. It may, on the other hand, indicate that "recently deceased members" were less addicted to post-impressionism and similar phases of art than those still living.

Thirty-six artists are represented in the exhibition. Of those who excelled in landscapes Sir Ernest Waterlow must be mentioned. He is represented by eighteen works of almost uniform excellence. Alfred Parsons's landscapes are equally pleasing, particularly No. 233, "River Scene," first exhibited in 1878. His garden pictures are not quite so successful, the flowers not presenting in all cases an entirely natural appearance. Napier Hemy, whose sea paintings are so well known, is represented by several of these works, and also by views of the Thames in London, of which No. 80, "The Riverside, Chelsea" (1873), derives an added historical interest as showing a wooden bridge over the Thames in the foreground, the familiar square tower of Chelsea old parish church being seen behind. Much more ancient history is shown in "The Catapult" (No. 208), a stout wooden apparatus manipulated by Roman soldiers in the siege of a walled city. The construction looks strangely modern.

Peter Graham's works show much more variety than was to be found in his recent paintings. One of the earliest shown, "A Spate in the Highlands" (No. 105), exhibited in 1866, is typical of his modern work with hill-mist in a Scotch glen, but without cattle. Then in 1873 came a Highland farm scene, and in 1896 and 1898 two really excellent pictures of sea and rocks (Nos. 191 and 216). It is a great pity that a subject in which the artist showed such skill should have been entirely discarded later in favour of the mountain scenes, successful as these were. It would not be fitting to close this note without favourable mention of Briton Riviere's numerous scenes from animal life, some of which are very striking.

J. S. D.

Botany of the Argentine Republic.

THE Anales (vol. 29, 1917) of the Museo Nacional de Historia Natural de Buenos Aires, recently received, a bulky volume of 700 pages, is devoted to the botany of the Argentine Republic. The earlier portion of the book contains the first part of a catalogue of the flowering plants, with the preparation of which Messrs. Hauman and Vanderveken have been occupied since the foundation of the botanical section of the museum in 1914. The catalogue consists of a list of all the species recorded for the area, under their families, which are arranged according to Engler's system. The entries in each family have been revised by the latest monograph dealing with the family in question. Under each species references are given to the publications on the authority of which the species is included. A systematic enumeration of the results of botanical explorations in this large area of temperate and sub-tropical South America has been much needed, and it is to be hoped that the authors will carry it to completion. A communication by Mr. Hauman on the orchids of the Argentine gives some indication of the work which remains to be done.

Two main groups are represented, a sub-Antarctic (Patagonian-Andine) and a sub-tropical, the latter being the more important. The present work has increased by 50 per cent. the number of genera and species belonging to the sub-tropical group. Mr. Hauman also supplies a number of floristic notes, which conclude the series of memoirs he has already published on the Monocotyledons of the Argentine, in which he has added some seventy species to the flora, about one-third of which are new. The volume concludes with a revision by Mr. Carlos Spegazzini of the Argentine Laboulbeniales, that remarkable group of minute fungi which live parasitically on insects. The enumeration includes 213 species, each of which is carefully figured; a large proportion are described for the first time. The volume is a very important contribution to our knowledge of the botany of temperate South America.

University and Educational Intelligence.

DR. A. SMITH WOODWARD will give a lecture on fossil man, with special reference to the Rhodesian skull, on Tuesday, January 24, at 5.30 p.m. at University College, London. Tickets for the lecture, at 5*s*. and 2*s*. 6*d*., can be obtained from the Secretary of the college. The proceeds will be devoted to the St. Christopher's Working Boys' Club in Fitzroy Square, which is largely worked by students and members of the staff of University College. The chair will be taken at the lecture by the Right Hon. the Earl of Plymouth, who is president of the club.

THE second term at University College, London, begins on Tuesday next, January 17. The following are some of the public lectures to be given during the term:—"Industrial Unrest," by Mr. B. Seebohm Rowntree; "The Bridges of London," by Mr. A. T. Walmisley; "The Preservation of Ancient Buildings," by Mr. A. R. Powys; "The Evolution of Man" (four lectures), by Prof. G. Elliot Smith; "The University of London: Its History, Present Resources, and Future Possibilities," by the provost, Sir Gregory Foster; and two lectures by Sir George Aston on "Some Principles of Amphibious Warfare" and "War History and its Application." A copy of the full programme may be obtained by sending a stamped addressed envelope to the Secretary, University College, London, W.C.1.

THE annual general meeting of the Incorporated Association of Head Masters was opened on January 4 at the Guildhall, and the new president, Mr. C. M. Stuart, delivered his inaugural address. Mr. Stuart stated that the two most revolutionary changes in education—the introduction of the schemes for 25 per cent. of free scholars and advanced courses—were instituted without consultation with secondary school representatives. In consequence, the original schemes had already required several modifications. The whole scholarship system needed reform based upon the study of the capacities of boys. In making awards it was of no use to go below the first 10 per cent., for this meant rewarding mediocrity, and it was by no means certain that the best from among the mediocrity were selected. The following resolution was carried unanimously by the meeting:—"That this meeting, while recognising the need for economy in every department, is of opinion that the recently awakened public interest in education demands that no hindrance of any kind shall be placed in the way of educational progress."

Calendar of Industrial Pioneers.

January 13, 1890. Daniel Adamson died.—A pioneer in the use of Bessemer steel for boilers, in the application of hydraulic power for riveting, and in the use of high-pressure steam, Adamson in 1861 built one of the earliest triple expansion engines. He became the head of the Penistone Ironworks, served as president of the Iron and Steel Institute, and was one of the chief promoters of the Manchester Ship Canal.

January 14, 1908. John Macfarlane Gray died.—When manager of a works at Liverpool Gray in 1866 constructed for the s.s. *Great Eastern* the first successful steam steering engine, thus enabling one man to do what had previously required as many as one hundred. He was well known for his writings on thermo-dynamics and his advocacy of the application of scientific principles to engine construction.

January 14, 1830. Johan Georg Repsold died.—The founder of the famous firm of instrument makers, Repsold was born in 1771, and was long connected with the Hamburg Fire Brigade. He introduced improvements in meridian circles and supplied many instruments to the large observatories.

January 15, 1900. Thomas Egleston died.—After graduating at Yale, Egleston studied for some years at the Ecole des Mines in Paris, and in 1863 initiated the plan for the School of Mines of Columbia University, New York, where he held the chair of mineralogy and metallurgy for thirty-three years.

January 17, 1909. Francis Elgar died.—Trained in Portsmouth Dockyard, Elgar became one of the first fellows of the Royal School of Naval Architecture and Marine Engineering at South Kensington. He was assistant to Reed, Adviser to the Japanese Government, John Elder professor of naval architecture at Glasgow, Director of Dockyards, and head of the Fairfield Shipbuilding Company.

January 17, 1833. Friedrich König died.—At the age of thirty-two, in 1806 König removed from Leipzig to London, and in 1811 with Andreas Friedrich Bauer (1783–1860) patented the printing machine in which the paper was pressed against the type by a revolving cylinder. On November 28, 1814, the *Times* was first printed on one of König's machines driven by a steam engine, "a memorable day in the annals of typography."

January 18, 1861. John Heathcoat died.—A journeyman frame-smith, Heathcoat at Loughborough in 1808–9 brought out his lace-making machines. The first square yard of plain net sold for 5*l*.; the price in 1890 was 5*d*., while the annual value of the trade had grown to 4,000,000*l*. Heathcoat's factory at Loughborough was destroyed by the Luddites in 1816 and he removed to Tiverton.

January 18, 1865. James Beaumont Neilson died.—While in charge of the Glasgow Gasworks, where he introduced clay retorts and the use of sulphate of iron as a purifier, Neilson experimented on the air-supply for blast-furnaces, and in 1828 patented the "hot blast," which enormously increased the production of iron and made available the black band ironstone discovered by David Mushet. It has been said Neilson did for iron manufacture what Arkwright did for the cotton industry.

January 18, 1873. Pierre Charles François, Baron Dupin, died.—A student of the Ecole Polytechnique, Dupin first gained distinction by his papers on naval architecture and engineering. He made a profound study of the industries of Great Britain and was one of the first in France to raise statistics to the rank of a science.

E. C. S.

Societies and Academies.

LONDON.

Geological Society, December 21, 1921.—Mr. R. D. Oldham, president, in the chair.—H. B. **Milner**: The nature and origin of the Pliocene deposits of the County of Cornwall and their bearing on the Pliocene geography of the south-west of England. Tertiary deposits of Cornwall at St. Agnes, St. Erth, Lelant Downs, Polcrebo, and St. Keverne have been provisionally assigned to the Pliocene period; except those of St. Erth, all are unfossiliferous. The average composition of the St. Agnes, St. Erth, and St. Keverne deposits is substantially the same. On this basis correlation of the deposits is effected by (*a*) the frequency of occurrence of individual species, (*b*) their persistence or distribution, and (*c*) the constancy of crystallographical, physical, and optical properties of grains of the same mineral, wherever met. The source of the material is essentially local. The gradual "swamping" of sediment-bearing rivers by the advancing Pliocene sea from the south-west is correlated with certain physical features apparent, especially the "400-ft. plateau."—L. **Owen**: The phosphate deposit of Ocean Island. Ocean Island, in the Western Pacific Ocean, consists of a mass of terraced and dolomitised coral-limestone which rises to a height of 300 ft. above low water, spring tide. Its surface is almost completely covered by a capping of calcium phosphate of exceptional purity which can be divided into three varieties: (*a*) Amorphous calcium phosphate, formed of the insoluble residue of the original guano; (*b*) detrital coral-limestone, converted into calcium phosphate by solutions leached from the guano; and (*c*) phosphatised coral *in situ*. The percentage of tricalcium phosphate at any point varies in a remarkably regular manner, according to the position of the point on the island, suggesting that (*a*) the original guano was deposited on the coral base during a slow negative movement of the strand-line, and (*b*) subsequent to the formation of phosphate the island was tilted at about a third of a degree south-south-eastwards.

EDINBURGH.

Royal Society, December 5, 1921.—Prof. J. W. Gregory, vice-president, in the chair.—Prof. **Jehu**: Observations on the geology of Iona. The Archæan complex of the western and greater part of Iona consists mainly of orthogneisses of dominant acid and hornblendic types, although pyroxene-hornblende gneiss and garnetiferous pyroxene granulites also occur. Paragneisses of various kinds are found at isolated localities as lenticular masses in the orthogneisses. On the south coast the forsterite-tremolite marble (Iona marble) is associated with hornfelsed green rocks, some of which are altered sediments and some altered igneous rocks. The paragneisses are younger than, and unconformable to, the orthogneisses, and represent remnants of pre-Torridonian rocks which became infolded with the orthogneisses. A massive white pegmatite forms a prominent feature in the landscape from the marble quarry on the south coast to near the centre of the island. A belt of Torridonian beds lying unconformably on the Archæan forms the eastern margin of the island, and consists of a lower group of epidotic conglomerates and grits and an upper group of finer grits, slates, shales, and banded flags. The Torridonian series of Iona may be correlated with the lower parts of the Diabaig group of that series in Skye and other districts. In post-Torridonian time the Archæan and Torridonian rocks have been subjected to isoclinal folding, the Archæan series being dragged more or less into approximate parallelism with the Torridonian. Along the line of junction there has been considerable crushing, but no actual thrust. The Torridonian rocks show dynamic metamorphism, and the later intrusion of the Ross of Mull granite has resulted in a later thermal metamorphism. This granite forms three small islets close to the south-east shore, and probably underlies the southern half of Iona. A series of genetically connected minor intrusions occur, and, with the granite, belong probably to the Caledonian phase of igneous activity.—H. M. **Cadell**: The geology of the Blackness district. Recent borings for oil-shale and coal in the Blackness district south of the Firth of Forth have not disclosed much mineral wealth, but have provided a complete vertical section of the Oil-Shale series in that region, indicating a notable attenuation of the whole shale section towards the north and west. To the west of Blackness no workable oil-shale was found above the Burdiehouse Limestone, although the positions of the seams were recognisable. The borings were continued westward up to the Bo'ness coal-seams of the Carboniferous Limestone series through ground that had never been previously explored. Six distinct beds of limestone had been found varying much in thickness from place to place. The No. 5 limestone measuring from the top downwards appeared from its fauna to be the equivalent of the Blackhall Limestone of the West of Scotland. The old volcano of Binns Hill to the south of Blackness belonged to the volcanic horizon situated near the top of the oil-shale section between the Two Feet Coal and the overlying Raeburn Shale seam. There had been much boring and mining for shale under the east end of the hill, and the evidence showed that within a few hundred yards of the thick ash on the hill there was no ash under the Raeburn Shale where it was to be expected. Binns Hill had been a very small volcano, one of a group that emitted showers of ash after the formation of the Houston and Two Feet Coal seams over a district extending southward about seven miles. Under the whole district and below the Burdiehouse Limestone there was a large intrusive basalt sill, and Binns Hill and other small local ash-necks seem to have acted as geological safety-valves by which imprisoned gases escaped and blew up part of the fluid eruptive rock in the form of fine dust and ashes.

PARIS.

Academy of Sciences, December 27, 1921.—M. Georges Lemoine in the chair.—The president announced the death of Prof. Schwarz, correspondant for the section of geometry.—E. **Borel**: Quasi-analytical functions with real variables.—W. **Kilian**: A problem of the tectonic of the sub-Alpine chains of Dauphiné.—C. E. **Guillaume**: Recent fundamental determinations and verifications of the standard metres. Slight elongations in the lengths of the working standard metres of the International Bureau have been proved. The cause of the change is not clear, but is possibly due to the effects of cleaning. Recent determinations of the coefficients of expansion of the bars have proved a small error in the opposite direction, and at the present time these errors compensate each other at about 15° C.—M. **Gevrey**: The determination of the integrals of partial differential equations, order $2p$, and m variables, admitting a multiple family of characteristics of order p.—G. **Bertrand**: Fredholm's equation and static masses of the first kind.—M. **d'Azambuja**: A mode of graphical representation of the filaments of the upper layer of the solar chromosphere.—J. **Villey**: The adiabatic liquefaction of fluids.

In a recent communication M. Bruhat has deduced from thermodynamical reasoning that the heat of vaporisation of a liquid at the absolute zero tends to a limiting value, not zero, and also that an adiabatic expansion sufficiently extended should always result in liquefaction. These conclusions have been objected to by M. Ariès. The author now shows that on the basis of the kinetic theory M. Bruhat's results are probable.—L. **de Broglie**: The theory of the absorption of the X-rays by matter and the principle of correspondence.—A. **Dauvillier**: Contribution to the study of the structure of the elements of intermediate atomic weight.—E. **Carvallo**: The problem of relativity in dielectrics.—R. **Boulouch**: The problem of achromatism.—H. **Pélabon**: The constitution of selenium. Different specimens of grey selenium are regarded as mixtures in variable proportions of two modifications, α and β, the α modification having a high resistance, the β a low resistance. The change in the specific resistance with temperature shows that the α changes into the β modification with absorption of heat. It is the α-selenium which is sensitive to light.—C. **Staehling**: The radio-activity of the uranium oxides. The changes in the radio-activity of the green oxides of uranium are attributed to the slow absorption of moisture; the black, strongly ignited oxide has a constant radio-activity, and is not hydrated on standing.—P. **Woog**: Relations between molecular properties and the capacity of fixing iodine of certain hydrocarbons.—M. **Samec** and V. **Ssajevič**: The composition of agar.—A. **Schoep**: Kasolite, a new radio-active mineral. The mineral was found at Kasolo, Belgian Congo, and occurs along with curite and chalcolite. It contains lead and uranium, and analysis gives the composition as

$$3PbO \cdot 3UO_3 \cdot 3SiO_2 \cdot 4H_2O.$$

—H. **Hubert**: New researches on the storm squalls in western Africa.—A. **Petit**: The cytology of two bacteria.—L. **Daniel**: New researches on grafts of Helianthus. An account of further experiments of grafting sunflowers on Jerusalem artichokes, with special reference to the weights of the tubers.—L. **Emberger**: Contribution to the cytological study of the sporangium in ferns.—M. **Boel**: The automatic adaptation of the angle of attack of flight in living insects. Study on the mechanism of natural flight.—M. **Nicloux** and G. **Welter**: The gravimetric quantitative micro-analysis of urea. Application to the estimation of urea in 1 c.c. of blood. The urea is precipitated as xanthylurea, and weighed on a Kuhlmann balance to 0·001 milligram.—E. **Aubel**: The attack of glucose and levulose by the pyocyanic bacillus. Glucose gave formic and acetic acids, with some ethyl alcohol. Levulose gave the same products, together with lactic acid.—E. **Chatton** and A. **Lwoff**: A new family of Acinetians, Sphenophryidæ, adapted to the branchia of the acephalous molluscs.—P. **Courmont**, A. **Rochaix**, and F. **Laupin**: The rhythm of the disappearance of ammonia in the course of the purification of sewage by activated sludge.—A. **Lumière**: The mechanism of the accidents caused by the injection of the serum of epileptics.—L. **Blum**: The antiphlogistic action of calcium salts.

Official Publications Received.

Office scientifique et technique des Pêches Maritimes. Notes et Mémoires No. 10: Le Controle Sanitaire de l'Ostréiculture. Par Dr. G. Borne, F. Diénert, et G. Hinard. No. 11: Le Conseil International pour l'Exploration de la Mer. Compte rendu Sommaire de la Session tenue à Copenhague, Juillet, 1921. (Paris: Ed. Blondel la Rougery.)

University of Illinois: Engineering Experiment Station. Bulletin No. 124: An Investigation of the Fatigue of Metals. By Prof. H. F. Moore and J. B. Kommers. Pp. 185. (Urbana: University of Illinois.) 95 cents.

Report on the Administration of the Meteorological Department of the Government of India in 1920-21. Pp. 14+1 chart. (Simla.) 4 annas.

Department of Fisheries, Bengal and Bihar and Orissa. Bulletin No. 17: Statistics of Fish Imported into Calcutta for the Year ending 31st March, 1921. Pp. ii+13. (Calcutta: Bengal Secretariat Book Depôt.) 8 annas.

Department of Agriculture, Madras. Bulletin No. 80: The Entomologist's Crop Pest Calendar for the Madras Presidency. By T. V. Ramakrishna Ayyar. Pp. 4+4 plates. (Madras: Director of Agriculture.) 2 annas.

The Marine Biological Station at Port Erin (Isle of Man). Being the Thirty-fifth Annual Report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool. (Read before the Liverpool Biological Society, November 11, 1921). Drawn up by Prof. J. Johnstone. Pp. 36. (Liverpool: University Press.)

Notes from the Royal Botanic Garden, Edinburgh. Vol. 6. Additional Plate Number. Addition to Numbers 29-30 (January, 1917). Plates 1-37. 2s. net. Vol. 13. No. 62. Pp. 67-100+plates 170-179. 1s. 6d. net. (Edinburgh: H.M. Stationery Office.)

Transactions of the Royal Society of Edinburgh. Vol. 53, part 1 (No. 3): Geological Observations in the South Shetlands, the Palmer Archipelago, and Graham Island, Antarctica. By D. Ferguson. Pp. 29-56+plates 1-4. 6s. 6d. Vol. 53, part 1 (No. 4): A Contribution to the Petrography of the South Shetland Islands, the Palmer Archipelago, and the Danco Land Coast, Graham Land, Antarctica. By G. W. Tyrrell. Pp. 57-80.—Vol. 53, part 1 (No. 5): On the Innes Wilson Collection of Rocks and Minerals from the South Shetland Islands and Trinity Island. By Dr. H. H. Thomas. Pp. 81-90. 1s. 6d. (Edinburgh: R. Grant & Son; London: Williams & Norgate.)

Diary of Societies.

THURSDAY, JANUARY 12.

ROYAL AERONAUTICAL SOCIETY (Juvenile Lecture) (at Royal Society of Arts), at 3.—Major D. C. H. Hume: Boats that Fly.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—J. E. Campbell: Einstein's Theory of Gravitation as an Hypothesis in Differential Geometry (II).—Miss G. D. Sadd: Rational Plane Curves.—Fritz Lettenmeyer: Neuer Beweis des allgemeinen Kroneckerschen Approximationssatzes.—T. Carleman: A Theorem Concerning Fourier's Series.—T. Stuart: Parametric Solutions of Certain Diophantine Equations.—W. P. Milne: Apolarity and the Weddle Surface.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Exhibition of Cinematograph Films.—P. Torchio, with explanatory notes by Dr. C. C. Garrard: Investigations and Tests on High-tension Switchgear.—F. Gill: Telephone Inventors of To-day.—F. Gill: The Audion.—F. Gill: Electricity in the Home.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at Food Reform Club, 2 Furnival Street, E.C.), at 7.30.—A. H. Keable: Super Centrifugal Force and its Application to the Clarification of Varnish and Dehydration of Oil.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Dr. C. J. Peddle: The Manufacture of Optical Glass.—Dr. J. W. French: The Barr and Stroud 100 ft. Self-contained Base Rangefinder.—T. Smith: The Optical Three Apertures Problem.

INSTITUTE OF METALS (London Section) (at Sir John Cass Technical Institute), at 8—Col. N. Belaiew: The Inner Structure of the Crystalline Grain.

HARVEIAN SOCIETY (Annual General Meeting) (at 11 Chandos Street, W.1), at 8.15.—Dr. G. de Bec Turtle: Some Points on Spasm in the Alimentary Tract (Presidential Address).

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Sir Frederick Mott and Dr. Uno: Changes in the Brain in Cases of Surgical Shock.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, JANUARY 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.—J. S. Paraskévopoulos: Jupiter in 1915 and 1916: Rotation Period in Different Latitudes, from Observations at the National Observatory, Athens.—Prof. G. Forbes: Solar Motion from 1922 Radial Velocities.—Major W. J. S. Lockyer: The Use of a Graduated Wedge in Stellar Classification and Parallax Work.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—E. C. West: Artificial Ice.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—M. L. Hepburn: Experience Gained from 150 Trephine Operations for Glaucoma.—H. Neame: Epibulbar Leucoma with Intraocular Involvement.

MONDAY, JANUARY 16

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—O. J. S. Crawford: The Archæology of the Ordnance Survey Maps.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Hunterian Lecture.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—E. H. Richards and G. C. Sawyer: Further Experiments with Activated Sludge.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—H. J. Paton: Plato's Theory of εἰκασία.

TUESDAY, JANUARY 17.

ROYAL HORTICULTURAL SOCIETY, at 1.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. F. H. A. Marshall: Physiology as Applied to Agriculture (1).
EUGENICS EDUCATION SOCIETY (at Royal Society), at 5.—Sir Frederick Mott: The Neuroses and Psychoses in Relation to Conscription and Eugenics.
ROYAL SOCIETY OF MEDICINE (General Meeting), at 5.
ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—H. W. Macrosty: Some Current Financial Problems.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. V. Lawley: Automatic Methods of Kinematograph Film Processing.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Dr. H. S. Stannus: Arts and Crafts from Nyassaland.
ROYAL SOCIETY OF MEDICINE (Pathology Section), at 8.30.—Sir G. Lenthal Cheatle: Multicentric Origin in a Case of Rodent Ulcer of the Trunk.—J. B. Buxton: Grass-disease and Botulismus.—Dr. A. B. Rosher and Dr. H. A. Fielden: Agglutinins for Bacilli of the Salmonella Group in Sera obtained from the General Population.—Dr. W. W. C. Topley: The Effect of Dispersal during the Early Stages of a Mouse-epidemic.

WEDNESDAY, JANUARY 18.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Hunterian Lecture.
ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. F. P. Wilson: The Plague in Shakespeare's London.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. A. C. Seward and R. E. Holtum: Jurassic Plants from Ceylon.—F. S. Wallis: The Carboniferous Limestone (Avonian) of Broadfield Down (Somerset).
ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Annual General Meeting.—R. H. Hooker: The Weather and the Crops in Eastern England, 1885-1921.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—Annual Meeting.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—W. Stoneman: Faces, Famous, Fair, and Funny.
ROYAL MICROSCOPICAL SOCIETY, at 8.—Prof. J. Eyre: Microscopy and Oyster Culture (Presidential Address).
ROYAL SOCIETY OF ARTS, at 8.—J. S. Huxley: Recent Advances in the Determination of Sex in Animals.
SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street), at 8.30.—Earl Russell and others: Discussion: Divorce and Birth Control.

THURSDAY, JANUARY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—S. Gordon: Mountain Birds of Scotland.
ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Prof. L. Hill, H. M. Vernon, and D. H. Ash: The Kata-Thermometer as a Measure of Ventilation.—Lt.-Col. C. B. Heald and Major W. S. Tucker: Recoil Curves as Shown by the Hot Wire Microphone.—E. W. A. Walker: Studies in Bacterial Variability: The Occurrence and Development of Dys-agglutinable, Eu-agglutinable, and Hyper-agglutinable Forms of Certain Bacteria.—Marjory Stephenson and Margaret Whetham: Studies in the Fat Metabolism of the Timothy Grass Bacillus.—J. A. Gardner and F. W. Fox: The Origin and Destiny of Cholesterol in the Animal Organism. Part 12: The Excretion of Sterols in Man.—Dr. S. J. Lewis: The Ultra-violet Absorption Spectra and the Optical Rotation of the Proteins of the Blood Sera.
LINNEAN SOCIETY OF LONDON, at 5.—Dr. E. Marion Delf: Studies in *Macrocystis pyrifera*, the Giant Alga of the Southern Temperate Zone.—J. L. C. Musters: The Flora of Jan Mayen Island.
ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—J. F. Allan: A Typical Example of Magmatic Injection.—W. E. Whitehead: Steep Sights in Underground Surveys.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Brig.-Gen. R. K. Bagnall-Wild: Aeroplane Installation.
INSTITUTION OF ELECTRICAL ENGINEERS (Joint Meeting with Institution of Heating and Ventilating Engineers), at 6.—Discussion: The Utilisation of Waste Heat from Electrical Generating Stations, with the following Introductory Papers: C. I. Haden: Utilisation of Exhaust Steam from Electric Generating Stations, and Coal Economy.—F. H. Whysall: The Utilisation of Waste Heat from Electrical Generating Stations.
CHEMICAL SOCIETY, at 8.—Prof. A. Smithells: Models of the Lewis-Langmuir Atom, with Explanations.

FRIDAY, JANUARY 20.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Hunterian Lecture.
ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—A. Tweedie: Short Account of the Research Work being conducted in Utrecht on the Saccular, Utricular, and Allied Reflexes (continued).
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—H. S. Denny and N. V. S. Knibbs: Some Observations on a Producer-gas Power Plant.
ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. Zimmern, Dr. Agnes Savill, Dr. Sloan-Chesser, Dr. C. A. Robinson, Dr. W. J. Turrell, and others: Discussion: Electro-therapy in Gynæcology.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir James Dewar: Soap Films and Molecular Forces.

SATURDAY, JANUARY 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. C. Macpherson: The Evolution of Organ Music (1).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

THURSDAY, JANUARY 12.

ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN, at 6.—Dr. W. K. Sibley: Electrical Treatments—Diathermy, etc. (Chesterfield Lecture).

THURSDAY, JANUARY 19.

KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (1).
ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN, at 6.—Dr. W. Griffith: Diseases of the Skin Appendages (Chesterfield Lecture).

FRIDAY, JANUARY 20.

METEOROLOGICAL OFFICE, SOUTH KENSINGTON, at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (1).
KING'S COLLEGE, at 5.—Prof. R. Robinson: Orientation and Conjugation in Organic Chemistry from the Standpoint of the Theories of Partial Valency and of Latent Polarity of Atoms (1).
KING'S COLLEGE, at 5.30.—Rev. Dr. F. A. P. Aveling: Matter, Mind, and Man.

SATURDAY, JANUARY 21.

UNIVERSITY COLLEGE, at 10.30 a.m.—A. Chaston Chapman: Yeast: What it is, and what it does (Lecture for Teachers).
LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (1).

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NATURE

THURSDAY, JANUARY 19, 1922.

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British Scientific Instruments.

THE exhibition of British scientific instruments held under the auspices of the Physical Society and the Optical Society at the Imperial College of Science and Technology, of which a description was given in our columns last week, is a timely reminder of the importance of scientific instruments in the national economy. Modern civilisation is based, and must be increasingly dependent, on the extension of scientific knowledge and its applications to industry; and in these developments scientific instruments are an essential and predominant factor.

Of the part played by scientific instruments in the advancement of scientific knowledge there is no need to speak. The laboratories of the universities and kindred institutions where scientific research is prosecuted would be disabled were they without scientific instruments of the highest trustworthiness and precision. The variety and extent of the industrial purposes served by scientific instruments are so great that there is probably no important industry in the country which is not dependent on scientific instruments of one kind or another for the performance of its productive functions. Moreover, the field of application of scientific instruments is constantly widening; the uses of the microscope in the textile and steel industries, of the polarimeter in the sugar and essential oil industries, of the pyrometer in the metallurgical industry, and of X-rays in the iron and steel industries, are but a few of the many examples that could be cited to illustrate the invasion of scientific instruments into fields of industry in which they were at one time unknown. That the industries gain in sureness and accuracy and in a deeper and wider knowledge of the fundamental scientific principles involved is obvious. And the process continues and must continue. To-morrow new instruments will be devised and new uses found for old instruments.

Moreover, as was stated in the leading article published in NATURE of February 10, 1921, the scientific instrument industry, springing directly from the loins of science, and progressing as scientific knowledge widens, is one of the most highly skilled industries we have. Its expansion means a definite increase in the numbers of academic and technical scientific workers and of the most highly skilled artisans; and the national wealth, in any comprehensive conception of the term, must be enlarged by the increase of the numbers of such educated and skilled classes.

For these and other reasons a flourishing and efficient scientific instrument industry is vital to the nation, whether in peace or war. And, although it is obvious that the users of scientific instruments, whether in the industrial or academic domain, must not be prejudiced or hampered by being unable to obtain the best instruments, from whatever source, it would be a disaster of the first magnitude if British scientific instruments should not be produced equal to the best that the world has to offer.

If in some classes British scientific instruments fall somewhat below the standard of foreign instruments, in others they are unquestionably superior. It would be invidious to particularise minutely, but the following statement by the manager of a British firm of optical instrument makers, writing in the *Morning Post* of October 1 last, may be given in illustration:—

"In connection with the manufacture of optical instruments for research, a search has been made throughout the premier journals of the world devoted to physical science for the years 1910 to 1914. In each of them, in the Proceedings and Transactions of the Royal Society and in the *Philosophical Magazine* (Great Britain); in the *Physical Review* and the *Astrophysical Journal* (United States); in the *Comptes rendus* (France); and in the *Annalen der Physik* (Germany), there were without exception more references to instruments made by my firm here in London than to those of any other makers whatsoever. In the case of the *Annalen der Physik* there were 50 per cent. more references to my firm than to any other, the firm mentioned next in order of frequency being a well-known German one."

Facts like these are not so widely known, even among British scientific workers, as they should be.

A statement—originally, it may be, true in substance—is made that a certain type of foreign instrument is superior to any other; the statement grows to a legend and lives long after changes and developments have rendered it false or, at least, misleading; and the British instrument has to overcome much inertia of prejudice and fashion before it can secure the recognition which its merits deserve. It would be well if the leading scientific users of instruments would review from time to time their judgments of the quality and performance of instruments, so that improvements in British instruments may receive early recognition and the British manufacturer not be prejudiced by a belated preference for foreign instruments.

The present condition of the British scientific instrument industry is gravely compromised by the abnormal state of the international rates of exchange. Whatever legislative measures may be employed to help the industry over a difficult period, there can be no doubt that the most potent means of promoting the production of British scientific instruments equal to the best that the world can offer—a matter in which manufacturers and users are alike concerned—lies and must lie in an intensive and extensive application of scientific research to the fundamental scientific problems and the current technique of the industry. Other countries, notably Germany and America, we may be sure, will not neglect this. The leading British scientific instrument manufacturers have recognised the primary and paramount importance of scientific research. The British Scientific Instrument Research Association was founded in 1918, and its third annual report, which was reviewed in NATURE of November 17 last, gave ample evidence of the value to the industry of such an institution. It is true that, as is stated in the fifth annual report of the Committee of the Privy Council for Scientific and Industrial Research, "research cannot be expected to produce results at short and regular intervals"; but the Association has already produced results of immediate practical application and of economic benefit to the industry without losing sight of the fundamental researches, necessarily slower in coming to fruition, on which the progress of the industry must be based. Nor should it be overlooked that the co-operative research of the Association not only does not supersede, but stimulates and assists, the research work of individual firms which are members of the Association.

Moreover, where the Association, in view of its duty to the pressing needs of the industry, is unable to explore all the by-paths of pure scientific research that are opened out, arrangements have been made for extra-mural researches in the universities or kindred institutions for the prosecution of these relevant but more remote investigations. It must be remembered, too, that the Association, as the scientific centre of the industry, provides a needed *liaison* between the manufacturers and users of scientific instruments in this country, so that, on one hand, the manufacturers may be more fully informed of the needs of the users, and, on the other, the users may better appreciate the limitations imposed on manufacturers by the nature of materials and industrial conditions.

If the manufacturers will follow with patience and persistence the path of scientific research on which they have already made significant progress, there is every reason to hope that British scientific instruments generally will be, as many now are, supreme.

The History of Zeeman's Discovery, and its Reception in England.

Verhandeligen van Dr. P. Zeeman over Magneto-Optische Verschijnselen. Pp. xv + 341. (Leiden: Eduard Ijdo, 1921.)

TWENTY-FIVE years ago Dr. Zeeman, working at Leyden in the laboratory of Prof. Kamerlingh Onnes, achieved the epoch-making discovery which is now so abundantly familiar to physicists. Almost simultaneously he was appointed professor of physics at Amsterdam. To celebrate these events a volume of his collected papers, bearing on this branch of magneto-optics, has been published, under distinguished editorship, with a portrait and a few editorial notes and minor corrections.

This is the volume under review. It is a tribute to Prof. Zeeman from his friends and colleagues, on the occasion of the twenty-fifth anniversary of the announcement of his discovery to the Amsterdam Academy of Sciences on October 31 and November 28, 1896. It has an introduction in Dutch, dated October, 1921, which is signed by H. A. Lorentz, H. Kamerlingh Onnes, I. M. Graftdijk, J. J. Hallo, and H. R. Woltjer.

In commending this volume I would say that no one need be deterred from attending to it by reason of ignorance of the Dutch language: for our Dutch friends, with their well-known consideration, are polyglot in their publications, and there is plenty of English as well as French and German in the book.

The volume being mainly one of historical and permanent interest, it seems fitting to receive it with acclaim and to supplement it by an account

of the reception and speedy appreciation of the discovery in England. For in a quarter of a century a new generation of physicists has arisen, many of them so intently occupied with their own admirable investigations that perhaps the origin of much of our present knowledge of Nature is liable to be submerged. Especially may they fail to realise the anticipations of the great theorists, which enabled a little seed-fact to fit immediately into its cranny and quickly to develop magnificent blossoms.

As to its reception here, the beginning was extremely modest, and may be narrated thus: On December 24, 1896, there appeared in NATURE, vol. 55, p. 192, the usual report of a meeting of the Royal Academy of Sciences of Amsterdam, and in a paragraph abstracting a number of other communications to that society the following sentence occurs:—

"Prof. Kamerlingh Onnes communicated two papers: (*a*) by Dr. Zeeman, on the influence of magnetisation on the nature of the light emitted by a substance. Pursuing a hint given by Faraday, several experiments were tried. The principle was this: the light of the electric arc, being sent through a heated tube containing sodium vapour, is analysed by a Rowland's grating. The tube is placed between the poles of an electro-magnet. When acted on by the magnet, a slight broadening of the two sodium lines is seen, tending to show that forced vibrations are produced in the atoms by the action of magnetism; (*b*) by Dr. J. Verschaffelt on capillary ascent," etc.

This sentence, included in a long paragraph, was probably the first announcement in England; but it was so inconspicuous that it could scarcely have attracted much attention, had not Sir Joseph Larmor, this year's Copley medallist, been on the look-out for an effect of this kind. He had previously perceived that such a result was necessary theoretically; a fact which is demonstrated by, among other things, the following passage reproduced on p. 203 of his book, "Æther and Matter":—

"Each absorption line say of sodium vapour in a magnetic field will thus be more or less widened, and its main position also slightly shifted but only to a higher order of small quantities: and the same will apply to each line in the emission spectrum."

Larmor had indeed gone on to calculate the amount of displacement or broadening to be expected, and had found the effect too small to be observed; for, like everyone else at that time, he considered that the radiating body must be an atom or part of an atom with an $e/m = 10^4$. So directly Zeeman got an effect, and found that the e/m was really of the order 10^7, Larmor perceived that, not the whole atom, but the charge only—the electron part of the ion, or an electron itself—was a free radiator, and wrote to me suggesting that I should examine and confirm the result. In a week I had done so, with such appliances as were to hand; though not without sufficient difficulty to make me realise the naturalness of Faraday's failure to see anything—he being wholly unguided by theory—and to admire the skill of Zeeman in detecting the effect.

Prof. Zeeman must soon afterwards have communicated his observations to the Physical Society of Berlin; for in NATURE, vol. 55, p. 347, is a translation of a short paper by him, dated from Amsterdam and thanking Prof. K. Onnes for his interest in the work.

The first official notice in England occurs in the Proceedings of the Royal Society for February 11, 1897, when a note by me entitled "The Influence of a Magnetic Field on Radiation Frequency" was received and read on the same day. It gives an account of my repetition of Zeeman's experiment and directs attention to Prof. Lorentz's theory of it, together with his brilliant prediction about polarisation of the modified lines, and its experimental verification (see Proc. Roy. Soc., vol. 60, p. 513). It is followed, on p. 514, by a theoretical note by Sir Joseph Larmor, in which he emphasises the "electron" aspect of the matter, and its reciprocal relation to Faraday's first magneto-optic effect. He also directs attention to previous memoirs by Helmholtz in 1893, and by Lorentz in 1892 and 1895, especially the former; and he cites p. 813 of his own splendid Memoir in Phil. Trans., A, 1894.

I also communicated a much longer article to the *Electrician* for February 26, 1897, vol. 38, p. 568, under the heading, "The Latest Discovery in Physics": an article which I should like to reproduce here, for I venture to say that portions of it are worthy of reference by anyone interested in scientific history. The freedom with which we all spoke of electrons and their motions in those days rather surprises me, seeing that the unit charge was not isolated and clinched until 1899. But, of course, the theoretical work of Dr. Johnstone Stoney and others had long preceded this date.

There was no excuse for not fully understanding the main perturbations of spectrum lines when once the idea of electrons revolving like satellites in regular orbits, obedient to astronomical laws, had been grasped; for Dr. Johnstone Stoney's remarkable paper, entitled "On the Cause of Double Lines and of Equidistant Satellites in the Spectra of Gases," was in my possession. (It will be found in the Transactions of the Royal Dublin Society for 1891, vol. 4, Series II., pp. 563–608.)

But the difficulty was that at that date we all—

except perhaps Larmor and Lorentz—thought of an electron as of something attached to an atom, making it an ion, in accordance with Faraday's electrolytic ideas; and the notion of a free satellite electron, inside the boundary of an atom, was of later growth. In fact, it was a development largely brought about by Zeeman's discovery.

Parenthetically I may remark that there is some risk of Dr. Stoney's contributions to science being overlooked, partly because the Transactions of the Royal Dublin Society are not so readily accessible as some other publications, and partly because he expressed himself in terms and ways not always in accordance with ordinary custom. Let me put on record here, therefore, that, at that early date, 1891, he examined dynamically the problem of satellite electrons perturbed from a simple orbit by unknown forces. He deals with elliptic, apsidal, and precessional motions, with periodic changes in each, and clearly depicts the double and treble and quadruple lines which would result.

He is not dealing with perturbations excited by some definite outside physical cause, such as a magnetic field applied to the source, but with the normal series of lines observed by spectroscopists—Balmer, Kayser and Runge, etc.; and the inference he draws is that many of the known groups can be accounted for on the analogy of astronomical perturbations. The problem he set himself is thus worded (p. 569):—

"We shall accordingly, for the present, regard certain points in the molecules of the gas as acting dynamically on an æther capable of receiving and transmitting only transverse vibrations, and we have to inquire what motions of these points within the molecules would impart to the medium the oscillations which correspond to the observed lines in the spectrum."

To return from this digression. Whether on account of my article in the *Electrician*, or because I had written direct to Prof. Zeeman (probably for the latter reason), he sent me the MS. of a finished paper of his, giving the experimental details and also his version of Lorentz's theory developed on equations like those of the Foucault pendulum; and this paper I at once communicated to the *Phil. Mag.* for March, 1897 (vol. 43, p. 226), adding a brief footnote to say that I had verified the author's results so far as related to emission spectra and their polarisation. This memoir is now reproduced as the first in the volume of Zeeman's collected papers just issued, and it is printed in four languages—Dutch, English, French, and German; but the English and other versions contain an appendix, not in the original Dutch, giving an account of the attempts made long ago by Faraday, and likewise a theoretical anticipation by Prof. Tait in 1875 (an anticipation based on Kelvin's general theory of magneto-optic rotation), together with the record of a contemporary failure experimentally to detect any such effect. This appendix also removes from competition some apparently similar but not identical observations made by a M. Fievez.

It is of interest to find that in this remarkable and fundamental paper by Prof. Zeeman the possible effect of solar magnetism on the sun's radiation is indicated as a subject for inquiry—a development afterwards so brilliantly followed up by Prof. Hale.

In May, 1897, I communicated another note to the Royal Society (Proc. Roy. Soc., vol. 61, p. 413), in which details of the appearance of the lines are given, and the curious complexity of some of them; also, which surprised me, a difference between the behaviour of the components of the pair of sodium lines. The red cadmium line was also examined, and other spark spectra. The substance of this paper is reported in NATURE, vol. 56, p. 237. And in the same month (on May 19) I exhibited the effect at the Royal Society soirée, as appears from the following entry in the Year-book for 1897, p. 119:—

"*Demonstration of Zeeman's Discovery of the Broadening of Spectrum Lines by the Action of a Magnetic Field on the Source of Light. Exhibited by Prof. Oliver Lodge, F.R.S.*

"Sodium lines produced by an oxyhydrogen flame between the poles of a powerful magnet are examined by means of a Rowland concave grating (the one with which Mr. George Higgs photographed the solar spectrum), and can be seen to broaden whenever the magnet is excited. A nicol or other analyser shows that the light of changed refrangibility is polarised, as it would be if the source of radiation consisted of revolving electrified particles whose motion is accelerated or retarded by magnetic lines of force through the plane of motion.

"Recent Observations.—By reason of reversals, the usual appearance of each sodium line is as if it were doubled; the magnetic field makes it appear triple, or even quadruple. A nicol properly oriented removes the magnetic effect. D_1 shows it more sharply than D_2. The new lines intrude into the middle, after the fashion of Newton's rings."

It may seem from this that the observation of doublets and triplets, as indicated by the theory, was made by me; but that I disclaim, as appears in the volume under review, p. 101, since, though I saw something like the real effect, I did not apprehend it clearly as a pure precessional effect (akin to that which Dr. Johnstone Stoney had worked out long ago), and was inclined to suppose that the magnetic acceleration and retardation of frequency, acting on a random collection of molecules, would be likely to

cause a confused broadening (see the *Electrician* of February 26, 1897, vol. 38, top of p. 569). I was still too much influenced by the idea of random atomic motions, instead of precise electronic orbits.[1] The real effect, as perceived in advance by Lorentz and realised clearly by Zeeman, was much sharper and more beautiful than that, and my suspicion of a more complex or mixed effect was unnecessary; the simple Lorentz theory served, just as cited in that same article of mine in the *Electrician* (except that I made a slip and gave a value for the perturbed frequency which I correct in the second following issue, p. 643 of the same vol. 38. Some remarks on e/m, interesting from an historical point of view, will also be found in that issue, and an extremely short formulation of the theory, thus: "Magnetised change of centripetal force, $eHr\omega = mrd\omega^2$, whence $d\omega = eH/2m$." Here also is the record of a temporary slip about the sign of the effect, made by Zeeman himself, for he at first announced that the radiating particle was a *positive* charge).

At the same time, a pure doubling or a tripling, characteristic of a truly circular or elliptic orbit perturbed by an apsidal or a precessional motion, is not the last word; for, though this is the standard of simplicity, each line in the spectrum is liable to have peculiarities of its own, depending on the nature of the electronic orbit which is magnetically perturbed; and hence there is found, not indeed mere broadening, but a quadrupling, sextupling, and other varieties of effect, such as are now well known, but which I confess surprised me when first I saw their indications.

In the *Phil. Mag.* for December, 1897, is an important theoretical paper by Sir Joseph Larmor, "On the Theory of Magnetic Influence on Spectra, and on the Radiation from Moving Ions." Towards the end of this paper he deduces his fundamental expression for radiative power, as proportional to square of charge and square of acceleration. Non-radiation from charges moving at uniform speed *seems* to be indicated—which would be very convenient in making unperturbed atoms permanent—but unfortunately centripetal acceleration seems equally destructive to their constitution, were it not for the modern device of quanta.

In this same volume of the *Phil. Mag.* (vol. 44, pp 55 and 255) are two additional papers by Zeeman, also reproduced in the book under review, constituting the real publication of the occurrence of definite doublets and triplets in the magnetic field; and they are followed in this book by another one giving metrical results obtained photographically.

Photographic records of the effect were, indeed, tried for by other experimenters, though without success (see Nature, vol. 56, p. 420). In Nature, vol. 57, p. 173, however, Thomas Preston reports complete success, in Dublin, with a fine grating belonging to the Royal University of Ireland, mounted in accordance with Rowland's geometrical-slide design. But on p. 192 of the same volume a meeting-report shows that Zeeman had exhibited specimens of similar photographs at the Amsterdam Academy a month earlier; and he was now able to apply the photographic method to the obtaining of more exact measurements, as mentioned in the *Phil. Mag.* for February, 1898, p. 197. See also Preston, p. 325 of the same volume (vol. 45), by whom a plate showing the various appearances with great distinctness is submitted. A few pages further on (p. 348) is a communication, which still further emphasises complexities and individual peculiarities in the magnetised lines, by Prof. Michelson, who here begins to apply to them his remarkably powerful "visibility" test, which was first elaborated in the *Phil. Mag.* for September, 1892 (vol. 34, p. 280), as a sequel to his earlier more theoretical paper in April, 1891, and is now employed with such skill and brilliant success at Passadena to measure the diameter of stars.

In further papers by Zeeman the spectrum of *iron* is specially examined, and a lack of symmetry detected in some of its lines. And presently the resolving power of the Michelson echelon is pressed into the service for the further examination of details, with results which are described and expounded through the remaining 200 pages of this interesting memorial volume.

The extreme importance of Zeeman's great discovery, and the admirable way in which he worked it out with the inspiring theoretical assistance of Prof. H. A. Lorentz—so that theory and experiment went hand in hand, as it is to be wished they did more often—may be allowed to justify and excuse this somewhat personal welcome of its twenty-fifth anniversary by an English physicist.

Oliver Lodge.

[1] Incidentally and generally, it cannot be unknown, but it seems to be sometimes overlooked, that every *regularity* tends to evade the equipartition of energy difficulty: for Maxwell's proof requires the motions to be not only interchangeable, but also completely random.

The Kaiser Wilhelm Institute.

Festschrift der Kaiser Wilhelm Gesellschaft zur Förderung der Wissenschaften zu Ihrem zehnjährigen Jubiläum Dargebracht von ihren Instituten. Pp. iv+282. (Berlin: Julius Springer, 1921.) 100 marks.

The Kaiser Wilhelm Gesellschaft zur Förderung der Wissenschaften owes its origin to the action of certain leading industrialists

connected with the principal chemical establishments of Germany who were concerned as to the future of science, and more particularly of physical science, in that country. In their opinion the German university system no longer sufficed to meet modern requirements in regard to research in abstract science, and they suggested to the All Highest the creation of an institution which should be wholly and exclusively devoted to research, and should be staffed by men of proved capacity to undertake its successful prosecution. They so far succeeded in impressing the Emperor with their views that he in his turn suggested to his memorialists, and to others who sympathised with them, that they should themselves find the money needed to endow and equip the contemplated institution, and, by way of showing his practical interest in the project, he further indicated what amounts the several industrial concerns, or their representatives, might be expected to contribute.

The society was duly inaugurated with all the pomp and ceremony which usually characterised any function or enterprise with which William II. desired that his name should be specially associated, and the occasion was further made memorable by the address which the late Prof. Emil Fischer then delivered.

The institution thus established at Berlin-Dahlem has now been in existence for ten years, and it has been thought expedient by those connected with its working to celebrate its "zehnjährigen Jubiläum" by the publication of a "Festschrift." By us a jubilee is usually understood to mean the celebration of a period extending over fifty years, corresponding to the Grand Sabbatical Year of the Jews, although there has grown up a certain laxity in the use of the term which is frequently held to denote a season or occasion of public festivity, which may or may not recur at stated periods. What were the precise reasons in the minds of those responsible for the management of the institution which led them to direct public attention to it at this particular time can only be surmised, for there is nothing by way of preface or introduction to the "Festschrift" to inform us.

The celebration of a jubilee after so short an interval as ten years, during half of which time the work of the society was seriously disturbed and hindered by the war, has, when we have regard to the unsettled condition of Germany, somewhat the appearance of a political move. It will not be forgotten that it was at the Kaiser Wilhelm Institute "for the Promotion of Science" that Geheimrat Haber made his experiments on poison gas, prior to the Battle of Ypres, which initiated a mode of warfare which is to the everlasting discredit of the Germans. We are not aware that the present Government has shown itself inimical to the interests of science; unlike Coffinhal, it has never pronounced "La République n'a pas besoin de savants." On the contrary, Germany realises that she owes too much to science during the last half-century, and especially during the critical years of the war, for her to be unmindful of its benefits. Whatever form of government she may ultimately adopt, she is too much beholden to science to neglect its claims, and there is no reason to believe that these claims will be less adequately met by a republic than by a monarchy. At the same time, it cannot be doubted that the impoverishment of the country will react disastrously upon the position and prospects of all institutions which, like the Kaiser Wilhelm Society, are dependent upon public funds or private munificence.

Although we are prepared to welcome every sign of renewed scientific activity in Germany, it cannot be said with strict regard to truth that this "Festschrift" is in any sense epoch-making. There is certainly nothing jubilant about it. It is divided into two main portions, one of which, consisting of thirty-three short papers extending in all over 243 pages, deals with natural science; the other, consisting of four papers, is concerned with the science of history, and is comprised within eighteen pages. Of the natural science papers the greater number relate to relatively small points of bio-chemistry; the others are about equally divided between subjects of pure and applied chemistry and physical chemistry. Among the contributors are Abderhalden, "Zur Kenntniss von organischen Nahrungsstoffen mit spezifischer Wirkung"; Armbruster, "Tiere als Tierzüchter—Eine Erklärung ihres Sozialismus"; Einstein, "Eine einfache Anwendung des Newtonschen Gravitationgesetzes auf die Kugelförmigen Sternhaufen"; Haber, "Uber Wissenschaft und Wirtschaft"; Carl Neuberg (who edits the volume), "Uber den Zusammenhang der Gärungserscheinungen in der Natur"; Prandtl, "Neuere Einsichten in die Gesetze des Luftwiderstandes"; and Stock, "Die Chemie des Leichtflüchtigen." Many of the papers are short historical summaries of the present state of knowledge on the particular point dealt with. Some of them, in fact, read as if they were amplified excerpts from university courses of lectures. Others are simply *réchauffés* of work which has been published in detail elsewhere.

The papers on the science of history comprise one by von Harnack on "Die Apokalyptischen

Reiter," and—curious association—two short notices relating to the Emperor William I. These deal with the Frankfort Congress of 1863, and with episodes in 1870 at Ems, and at Sedan. The notes of the conversation with the French Ambassador Benedetti at the former place (July 13 and 15, 1870), and with Napoleon III. at the latter place (September 2, 1870), are of historical interest, and are among the few papers of permanent value contained in the book.

The price of the brochure, which is issued in paper covers, is stated to be 100 marks, which, considering the present value of German currency, is not excessive, however significant of Germany's financial straits. The book is admirably printed on excellent paper, and is suitably illustrated. It does credit, in fact, to the eminent firm by which it is published. The war and its consequences have evidently had no detrimental effect on the typographical excellence of book production in Germany.

Fish Preservation.

Fisheries—England and Wales. Ministry of Agriculture and Fisheries. Fishery Investigations: Series 1, Freshwater Fisheries and Miscellaneous. Vol. 2, No. 1, *The Methods of Fish Canning in England.* Pp. 25. (London: H.M. Stationery Office, 1921.) 2*s.* 6*d.* net.

THE development of methods of preserving fish was a matter of national importance during the war, and the present account is founded on investigations started in that period. The fish used for canning are mostly surface-feeding and living fish, such as sprats (or bristling), sardines (or pilchards), tunny and bonito, herring and mackerel, the only other fish of any importance being the salmon caught in America on its migration to fresh water for breeding. Of British fish there is a great excess of herring in the normal fisheries, and, given suitable fishing gear, large quantities of sprats can also be obtained on all coasts. Mackerel are at times abundant, but there is little certainty of heavy catches year by year; pilchards are local to Cornwall, and the immature forms (sardines), so extensively tinned in France, Spain, and Portugal, are not caught in quantity. There was one British sprat cannery before the war, but herrings were put up at the great herring ports in oil or with tomato, the product being in some cases excellent. Excess sprats were generally used for manure, while herrings were salt-pickled and barrelled for export, the price being two or three for a penny. The latter is an "unspeakable" product, which has never found favour in this country, and fresh methods of preservation are urgently requisite for the utilisation of herrings as a cheap form of food. The markets, too, of Central and East Europe, which took most of this product, are disorganised, and it is doubtful whether they can ever be recreated, as there would seem to be a real improvement in Continental taste, brought about by the temporarily improved food conditions of the war.

The success of different kinds of fish as canned products depends largely on the fat which lies under the skin and between the muscles. Salmon is canned or frozen in air (dry frozen) on the Pacific coast almost immediately when caught, certainly before *rigor mortis* has set in; the same is, to some degree, true also of the Norwegian sprats (bristling), of which there are about eighty factories in operation. The difficulty in Great Britain is that no port has a herring or sprat season extending through more than three or four months, and a factory with modern appliances and trained packers cannot be run profitably for such a short season. The fish required at other times must be brought in by rail, and this doubles the cost, while the actual fish has passed through its *rigor* and is deteriorating. It would seem necessary to get the fish as fresh as possible and to discover some method of preservation in bulk for subsequent packing, the process being one which would in no wise alter its composition or flavour.

Experiments with brine freezing and subsequent cold storage are described, but difficulty was experienced in the caking of sprats into masses and the salting, due both to the small size of the fish and to an excessive cold-store temperature "just under 30° F." Both these difficulties might perhaps be got rid of, but the total cost of the actual freezing, storage, transport, etc., would probably average 3*d.* per lb., which only a first-rate product could bear. Unfortunately, British sprats, as at present caught, are shown to be by no means such a product, being indeed much inferior to the Norwegian. According to the tables, they varied in fat from 5 to 23 per cent., protein being 15 to 20 per cent., ash about 1·5 per cent., the rest being water, which, with fat, roughly forms 80·5 per cent. The problem is to catch sprats of the right composition for pickling. The English fish is winter and spring caught, while the Norwegian fishery is in summer and autumn. The reproductive cycle has doubtless something to do with the quality, but little is as yet known of the life-history of the English fish. The difference lies probably, not in the fat contents, but in other

qualities, the winter fish being of inferior taste and texture. Clearly we must either continue to pack a second-rate product, or discover where our sprats go to in summer, invent methods of catching them, and finally adopt more "fastidious" methods of handling, all of which Dr. Johnstone clearly considers could be accomplished by further research. In contradistinction to the sprat our summer herring is said to be second to none.

After canning the flavour of the fish improves notably, the raw taste disappearing, the bones softening, and the flesh breaking easily; this is what is called "maturation," and the time required is from six months to as many years to give the best product. No suggestions or experiments to ascertain the cause of this proved satisfactory. It would not seem to be autolysis, for storage at a temperature of 37° C. did not hasten the process. Bacterial change is considered more likely, as spores can withstand a temperature of 150° C. if present in oil. Catalysis, however, cannot be ruled out, as the tin of the container is always to some degree dissolved. The whole question of "maturation" in respect to all canned foods is, as Dr. Johnstone says, "of huge practical importance—and of remarkable obscurity." It is certain that no commercial product can be stored for from three to six years and then sold cheaply.

The whole report is immature, in that the investigations were never made on a sufficient scale to be economically of value, and were prematurely closed down. It seems doubtful whether they can profitably be restarted until basal investigations, such as on the nitrogenous composition of the protein of fish in respect to phases of reproductive activity and to the formation of fat, are completed. On freezing and maturation the Food Investigation Board,[1] in the midst of other investigations, had been conducting researches for three years, but it is quite clear that there is plenty of room for less "directed" researches. Either the Fishery Boards should take up the whole problem, directly or through the Food Investigation Board, and vigorously prosecute it—even employing bounties if necessary—with a determination to create a new industry of value to an island nation, or drop it altogether. The Scottish Fishery Board made the export of salt herrings—in 1913 8,795,232 cwts. of value 5,331,042*l.*—a valuable British industry, by pursuing a consistent, steady policy through several decades. In the twentieth century Government officials seem to have little of the imagination required or to be afraid of the fluctuations of political affairs. They need not be, for surely these developments are national and not political, and such as "the man in the street"—and in the Commons—requires.

J. STANLEY GARDINER.

[1] See Report for 1920. (H.M. Stationery Office.) 1*s.*

Our Bookshelf.

The Microtomist's Vade-Mecum: A Handbook of the Methods of Microscopic Anatomy. By A. B. Lee. Eighth edition. Edited by Prof. J. B. Gatenby, with the collaboration of Prof. W. M. Bayliss and others. Pp. x + 594. (London: J. and A. Churchill, 1921.) 28*s.* net.

THE new edition of this well-known work of reference has been completely revised by Prof. Gatenby, who has had the assistance of experts in various branches of microscopical technique, and the result is a volume which is practical, critical, and thoroughly up-to-date. Prof. W. M. Bayliss has rewritten the chapter on staining, and his concise account of the nature of staining and of differentiation gives a clear conception of the physico-chemical facts on which these processes are based. Dr. C. Da Fano has been responsible for the five chapters on neurological technique, which form 100 pages of the book and contain many suggestions drawn from his extensive experience. Dr. A. Drew has rewritten the section on Protozoa, which, in addition to the methods for fixation, staining, etc., gives an account of cultural methods for amœbæ; Dr. W. Cramer contributes a dozen pages on the micro-technique of fatty substances, including a useful summary of the methods to be employed in a complete histochemical investigation of fatty cell-inclusions; and Mr. J. T. Carter has revised the account of methods for the study of teeth and bone. The remainder of the work has been in Prof. Gatenby's hands, and the sections on fixation, chromatin, nucleoli, mitochondria, and the Golgi apparatus are especially noteworthy and helpful in suggestions; mention should also be made of the short account of methods of tissue culture *in vitro*, which, in the hands of Ross Harrison and his successors, have given such remarkable results. The last chapter has been written for the beginner and gives clear directions for carrying through the preparation of a whole mount of a Daphnia, for making sections of muscle or other tissue of a vertebrate, and for preparing a tadpole for serial sections.

Two recent methods for staining bacteria have been introduced to help those who may be doubtful whether certain bodies in tissue are or are not bacteria. Having gone so far, the editor might perhaps consider whether he could include in the next edition the methods for the study of spirochætes which zoologists nowadays frequently find it necessary to examine. Under Annelids a reference to the preparation and mounting of chætæ would also be a useful addition.

The editor and his collaborators are to be warmly congratulated on the production of this thoroughly sound and practical guide, useful alike to students and to research workers.

A French-English Dictionary for Chemists. By Dr. Austin M. Patterson. Pp. xvii + 384. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 18*s*. net.

THE present volume is a companion work to the author's "German-English Dictionary for Chemists," and is likely to meet with an equally favourable reception. A practical test, working through original papers in organic chemistry, inorganic chemistry, and technical (engineering) chemistry proved the usefulness of the dictionary; only on the engineering side were a few deficiencies found. Chemistry has several other sciences on its borders, and this is recognised practically by the inclusion of some biological and botanical terms. The addition of technical words from mathematics, geology, and engineering, with more words from physics, botany, biology, and medicine would widen the scope of the book without necessarily increasing its bulk. It is stated in the introduction that "words of the same or nearly the same spelling in the two languages are defined even when the meaning is exactly the same as in English." This appears to the reviewer as a defect; the space might be better utilised in the direction just indicated. Thus, taking a page (368) at random, out of seventy-eight words sixteen have identical spellings and meanings; of the remainder, twenty-one are practically the same, and the obvious translation is the correct one, such as *uniforme, unimoléculaire, uranyle, ultramicroscopique.*

Handbuch der Holzkonservierung. Edited by Ernst Troschel. Pp. xi + 540. (Berlin: Julius Springer, 1916.) In Germany, 18 marks; in England, 54 marks.

TWELVE authors, comprising engineers, architects, foresters, and professors, have produced this comprehensive text-book, which contains the result of the latest investigations until 1916, on the preservation of wood. The book is clearly written and well illustrated. It contains references to most of the literature that has been published on the subject, in English as well as in German, and frequently discusses processes and materials used in England, India, the United States, etc.

The matter is arranged as follows: After an introductory chapter on the structure, function, and growth of wood and its tissues, part 1 deals with the destruction of wood by fungi, animals, and other agents. Dry-rot caused by Merulius, Lenzites, and other fungi, and the numerous injuries due to insects and marine borers, are treated at considerable length. The second part discusses the methods that are actually employed in preserving wood. These are very numerous, and most attention is paid to the processes involving impregnation with antiseptics, applied with or without pressure. The materials and machinery used are described in detail. The history of the subject is illustrated by a list of all the substances that have been tried from 1700 to 1876, with the name of the inventor and mode of application in each case.

The third part is concerned with the care of wood put to use under various conditions, as in the open air, under water, inside houses, etc. The influence of moisture and the action of chemical preservatives on the strength and durability of timber are briefly treated, most reliance being placed on Janka's experiments at Mariabrunn. The fourth part is very practical, containing special articles by engineers on the problems connected with the maintenance and preservation of the wood used in mines, railways, telegraphs, docks, bridges, ships, houses, street-paving, etc. An appendix, pp. 498–540, gives a list, classified under forty headings, of the most important patents in connection with the preservation of wood that have been taken out in all civilised countries.

Liquid and Gaseous Fuels and the Part they Play in Modern Power Production. By Prof. Vivian B. Lewes. Second edition. Revised and edited by John B. C. Kershaw. (The "Westminster" Series.) Pp. xiv + 353. (London: Constable and Co., Ltd., 1921.) 12*s*. 6*d*. net.

IN his revision of Prof. Lewes's work on liquid and gaseous fuels, Mr. Kershaw has adopted the plan, dictated in part, no doubt, by the need for economy, of inserting new matter in the form of footnotes collected at the end of each chapter. Thus when Prof. Lewes ventures upon a definition of an atom, we are referred to a footnote some five pages further on for more modern views on the subject; this becomes irritating. Substantial additions have been made to the first edition, which was reviewed in NATURE of December 5, 1907, p. 98, in the form of information relating to the manufacture and use of power alcohol, and in the appendices, which contain accounts of fuel oil burners and vertical continuous retorts for gas manufacture, as well as extracts of recent statistics of oil fuel burning.

The Fixation of Atmospheric Nitrogen. By Dr. Joseph Knox. (Chemical Monographs.) Second edition. Pp. vii + 124. (London: Gurney and Jackson, 1921.) 4*s*. net.

IN the revision of his useful little monograph Dr. Knox has added brief accounts of the Haber process and of ammonia oxidation. The statement in the preface that "comparatively little work of importance on the theoretical side has appeared since the first edition of this book was published" is scarcely justified, and the fact that, of the 169 references to the literature which are given, only about fifteen are of dates later than 1913 is not what one might expect. The account of the Serpek process, for example, is quite out of date, and no reference to Serpek's later publication is given. The book will no doubt prove as useful to students as the first edition, and is a readable introduction to a most important subject.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Generalised Lines of Force.

LET me direct attention to a notable paper by Prof. E. T. Whittaker, in the Proceedings of the Royal Society of Edinburgh for November last.

It has often been discussed whether electric or magnetic lines of force were the more fundamental, and which might be regarded as the "cause" of the other; a discussion rather like the old controversy as to the direction of vibration in a polarised beam of light. Maxwell's theory satisfied the disputants by making both directions equally important.

In this paper Whittaker extends Faraday's theory of lines of force to electromagnetic activities in general, expressing the complex facts by aid of the space-time continuum of Minkowski, whereby any form of kinematics can be expressed as a sort of four-dimensional statics. The solenoids of Faraday are shown to be special cases of a more general kind of surfaces, called *calamoids,* which reduce to ordinary electric lines of force when the field is purely electrostatic, while they reduce to ordinary magnetic lines of force when the field is purely magnetic; so that the Faraday electric and magnetic lines are not two distinct and (as it were) rival things, but two limiting cases of the same thing. The essential solenoidal condition—strength inversely as cross-section—is retained if, instead of electric or magnetic force separately, the contra-variant $\sqrt{(E^2-H^2)}$ is employed, and if the cross-section is that of a calamoid.

Ordinary equipotential surfaces, whether electric or magnetic, are seen to be special cases of an "electro-potential" or "magneto-potential" [? ether-potential] surface, which reduces to one or other of them whenever the field becomes static. These electro-potential surfaces, in general, exist in the four-dimensional world of space-time; but when the field is static each surface is wholly contained within three-dimensional space, and is an ordinary equipotential surface.

The property of the Faraday lines of force, that they are everywhere perpendicular to the equi-potential surfaces, is shown to be a case of the more general theorem that the calamoids are everywhere "half-orthogonal" to the electropotential surfaces; (half-orthogonality being the four-dimensional analogue of three-dimensional perpendicularity).

In electrostatics, the total strength of all the Faraday tubes which issue from a closed surface containing no electric charge is zero; similarly, in general radiation-fields, the total strength of all the calamoids which cross a closed surface is zero. This theorem provides an intuitive geometrical integration of the Maxwell-Lorentz equations of the electromagnetic field.

There are also elaborated generalised "divergence" and "curl" theorems, with a certain kind of absoluteness about them, since they are independent of the motion of any observer.

For much fuller and more trustworthy information Prof. Whittaker's paper must be referred to. He said something about it in Section A at the recent meeting of the British Association in Edinburgh, but I, for one, did not understand his meaning then, in the rush of Sectional procedure. The object of the present summary is merely to direct early attention to a paper which cannot be long overlooked.

December 28. OLIVER LODGE.

Units in Aeronautics.

WRITE the usual formula in aeronautics,

$$\frac{R}{S} = 23{\cdot}7\left(\frac{V}{100}\right)^2, \text{ lb/ft}^2,$$

in the Hospitalier notation, and the practical airman recognises that the resistance R, lb, over a surface S, ft², is at the rate 23·7 lb/ft² at a normal velocity of 100 f/s; and so on for any other velocity V, on the law of the square.

The airman pays no heed to any units except his foot and pound, and he has no use for any of the elaborate explanations of Mr. A. R. Low.

The factor 23·7 will be the result of experiment in the air-channel, reduced for air of standard conditions of barometer and thermometer on the ground.

But the air density is never measured in any of these experiments, and it is doubtful if the measurement has ever been carried out in any aeronautical laboratory.

In the early history of the Royal Society "weighing the air" was a favourite research. Charles II. bet Buckingham fifty guineas to one he would demonstrate the compression of air in his hollow walking-cane; but the other story of the fish in a bucket of water cannot be traced further back than Whateley, who is supposed to have invented it.

The air density arises in the formula of the treatise on aerodynamics on the idea that the formula is the expression of Newton's assumption that the resistance is due to the impact of inelastic air particles, as if air could be treated as a cloud of dust; and then at an air density w, lb/ft³, or better for calculation in thermo-aerodynamics, at a specific volume the reciprocal $C=1/w$, ft³/lb, Newton's formula becomes

$$\frac{R}{S} = w\frac{V^2}{g} = \frac{V^2}{gC}, \text{ lb/ft}^2; \quad \text{or } \frac{R}{S} = 2wh,\ h = \frac{V^2}{2g}.$$

In this treatment the Equation of Continuity is ignored; the air particles should stop dead and fall down in a heap at the foot of the aeroplane, to be swept up as dust.

Thus the mysterious factor 0·00237 of the treatise on aerodynamics is the equivalent of w/g, and with $g=32{\cdot}2$, f/s², this makes $w=0{\cdot}0763$, lb/ft³, $C=13{\cdot}1$, ft³/lb, so that this standard air bulks 13 cubic feet to the pound, in round numbers.

Another way of expressing the law is to write it in the equivalent form

$$\frac{R}{S} = \left(\frac{V}{H}\right)^2, \text{ lb/ft}^2,$$

so that H is the velocity at which normal resistance is 1 lb per square foot; then on the figures above $H=20{\cdot}5$ f/s, and this may be replaced by 20 in round numbers for practical calculation, making

$$\frac{R}{S} = 25\left(\frac{V}{100}\right)^2.$$

Flying over the ocean the velocity would be expressed in knots, K, and with 12 knots the equivalent of 20 f/s the formula is

$$\frac{R}{S} = \left(\frac{V}{20}\right)^2 = \left(\frac{K}{12}\right)^2, \text{ lb/ft}^2;$$

simple numbers easily remembered.

In all these calculations Perry's dictum must be respected: that the accuracy of a formula is only the accuracy of its most inaccurate part.

Here the index 2 of the velocity, adopted for simplicity of calculation, is the part most subject to doubt, and then at this rate of the quadratic law the above numbers, 23·7, 24, and 25, are all equally

suitable; their discrepancy is wiped out by small variation of air density or height of flight.

The practical airman will pay no heed to Mr. A. R. Low's elaborate explanation of the units employed in absolute measure (NATURE, January 5, p. 12). He has no use for poundal or slug units—fearful traps for the unwary and cause of great confusion of thought—and with the conceit to imagine they will pass current in the whole cosmos. But the rigour claimed for them is beginning to crack and show flaws under the merciless scrutiny of the new relativity.

Mr. Low is here coming to the rescue of the unhappy examinee, at the mercy of the whim of the examiner's text-book, and of the rigour demanded for the language employed there, ignored by the practical airman.

Divergence of language is never to disappear, as it seems, between science and engineering. The engineer refuses to budge when he finds he can arrive at a correct result in practice, and he ignores the rigour prescribed in the examiner's text-book as something to be thrown at the head of the examinee in his *conquête des diplômes*. G. GREENHILL.

Staple Inn, January 9.

Space and Æther.

THE relation of space and æther has been a subject of controversy. Three-dimensional absolute space has been regarded, before Einstein, as filled with a substantial æther. It is unnecessary to conceive the four-dimensional space-time of the relativists as so filled. If space-time is empty, is space also empty?

It seems to me that the crux of the difficulty is a wrong assumption that space-time is four-dimensional. Space-time is neither four-dimensional nor three-dimensional, but is two-dimensional. The orthodox analysis of the objective world down to the three fundamental entities of matter, space, and time has been incomplete. That which we call space also involves time. That which we call matter also involves both space and time. Thus what we call matter, space, and time should further be analysed as matter-space-time, space-time, and time where matter, space, and time with their new signification are fundamental entities. It is in this new sense that I shall use them hereafter.

Æther is the synthesis of space-times. It is matter-space-time. A synthesis is a petrified motion. We do not perceive the motion of æther because it is petrified. The motion in a space-time is independent of motion from space-time to space-time along the string that is æther. The so-called velocity of æther is not a change of space, but a change of matter.

Æther, being matter-space-time, partakes of the nature of all three. It has the density of matter, the rigidity of space, and the motion of time.

Æther is matter-space-time of no mind. The synthesis of matter-space-times of observing minds may be called hyper-æther—filling an absolute four-dimensional universe. Relatively to matter, æther is absolute. Relatively to mind, hyper-æther is absolute. The real is neither relative nor absolute, but is relatively absolute.

Einstein found that space-time was four-dimensional and that the universe was four-dimensional, and therefore argued that space-time was the universe. Therein lies his fallacy. His space-time is the two-dimensional section of a four-dimensional universe. There are two factors in evolution: persistence of identity and change of structure. As space-time is two-dimensional, its identity persists in the evolution from a three- to a four-dimensional universe. And as the world character changes, the internal structure of space-time changes. Einsteinian relativity is an anarchy. It marks a process of revolution, but does not attain a new position of stability.

Logic is not absolute, but is relative. The laws of logic of an absolute three-dimensional world are not the same as those of an absolute four-dimensional world. To study an absolute four-dimensional world we need a new logic, a new arithmetic, a new geometry, a new mechanics, and also a new science dealing not only with time as arithmetic does, not only with space as geometry does, not only with matter as mechanics does, but also with mind. On the recognition that time, space, matter, and mind contribute each a dimension to the universe I have been able to base an analytical geometry of the universe.

Space, in the sense of the arena of the three-dimensional universe, is matter-space-time, and may be regarded as filled with æther. The Euclido-Newtonian space-time and the Einsteinian space-time are non-material. But the latter is a stage of travail for the evolution of the former into a space-time with a new internal structure. The claim of the relativists to have demolished Euclid and Newton argues a want of the sense of historic perspective. Man does not progress by demolishing, but by building on, his past.

S. V. RAMAMURTY.

Trinity College, Cambridge, January 5.

Anisotropy of Molecules.

DIRECT evidence that the molecules of gases are not spherically symmetrical and are anisotropic in their properties is furnished by the recent experiments of Lord Rayleigh, who has shown that the light scattered by molecules is, in general, not completely polarised when observed in a direction transverse to the pencil of light traversing the gas. The method used by Rayleigh, and by those who have repeated the experiments establishing this effect is a photographic one, the track of the primary beam of light as viewed through a suitably oriented prism of Iceland spar being recorded on a plate with long exposures. In view of the great interest of the phenomenon, it occurred to the present writer that it would be worth while to attempt direct *visual* observation and measurement of its magnitude. The chief obstacle is, of course, the extreme feebleness of the unpolarised part of the transversely scattered light. This has, however, been successfully overcome. By using the strongest possible illumination (sunlight), securing a perfectly black background, and very carefully screening the eye from extraneous light, it has been found possible to detect with dust-free air at atmospheric pressure the non-extinction of the track as seen through a nicol at any orientation. With carbon dioxide the effect is quite conspicuous, and visual determinations of its magnitude have been successfully made by Mr. K. R. Ramanathan working in the present writer's laboratory.

A very interesting question arises whether it is possible to establish the same effect by observations on the polarisation of skylight. As is well known, there is a marked defect in the polarisation of skylight in a direction removed 90° from the sun, which is, however, in the main, due to dust and condensed water-vapour in the atmosphere and the diffuse lighting up of the sky by self-illumination and by reflection from the earth's surface. It occurred to me that the elimination of the effects due to these disturbing factors does not present insuperable difficulties. The reflecting power of landscape (about 0·08 when covered by vegetation) is known, and its effect is therefore calculable. Dust and low-lying mists may be prac-

tically eliminated by making the observations on a bright, clear day at a high-level station, and the self-illumination of the sky under the same conditions is very small *in respect of wave-lengths near the extreme red end of the spectrum.* The residual effect of self-illumination in these circumstances may be computed with sufficient accuracy by the method used by L. V. King (Phil. Trans. Roy. Soc., A, vol. 212, 1913), the uncertainties due to the neglect of the curvature of the earth and other simplifying assumptions in the calculation being then of little importance.

In order to obtain material for testing these ideas I made observations on the forenoon of December 4 last from the summit of Mount Dodabetta, in the Nilgiris (8750 ft. above sea-level), the sky at the time appearing beautifully clear, free from cirrus clouds, and almost completely black when seen through a deep red filter. The weaker component of polarisation was found to have 13 per cent. of the intensity of the stronger component. Diffuse illumination of the sky is capable of explaining only a part of this, a weaker component of about 8 per cent. intensity being indicated by the calculations. The residual 5 per cent. must therefore be ascribed to molecular anisotropy, and this is in agreement with the laboratory determinations of Rayleigh.

Observations on the molecular scattering of light in *liquids* made by the writer also show an imperfect polarisation attributable to anisotropy. Experiments in the same direction on the atomic scattering of light in crystals are being made, and an attempt is also in progress to discover the existence of an effect indicated by Sir J. J. Thomson's theory (*Phil. Mag.*, October, 1920), namely, the dependence of the results on the frequency of the scattered radiation.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta, December 19.

The Resonance Theory of Hearing.

MAY I reply to Dr. Perrett's letter (NATURE, December 29 last), in which he makes the objection to the resonance hypothesis that it does not explain how we perceive when there are two tones of the same pitch sounding simultaneously?

It seems to me that Dr. Perrett has made two slight errors:—

(1) There must be, he writes, one result, unique and without alternative, when the tracing of the combined wave-form of any two notes of the same frequency is submitted to Fourier analysis.

But surely this cannot be true; for example, if in one case the two tones are 256 vibrations per sec. from an oboe and a flute simultaneously sounded, the relative amplitudes of the overtones found by Fourier analysis would be quite different from those found for the same tone sounded simultaneously on a violin and a cornet. Not only would the amplitudes of the overtones differ in the two cases relatively to the fundamentals, but they would differ also relatively to one another.

(2) Dr. Perrett proceeds: "If the ear acts as a kind of practical Fourier's theorem, it can perceive only one fundamental tone. But we invariably judge of the pitch of a note by its fundamental tone. If, then, we hear at the same time two notes of pitch n, the ear must be able to perceive also at the same time two fundamental tones of frequency n—that is to say, it must be able to perform an analysis which is not in accordance with Fourier's theorem."

Surely Dr. Perrett has omitted in the above reasoning to take into account the existence of beats, overtones, and phases. If these did not exist, and if the ear could still tell whether one or more than one instrument were contributing to a tone, then the resonance theory would have met with a serious difficulty. But overtones do exist, and they are known to differ for different instruments, also for one instrument in different circumstances, *e.g.* the human voice when sounding various vowels. The resonance theory, in that it explains the perception of overtones, even when their intensity compared with the fundamental is small, also explains how we can tell whether two different instruments are contributing to a tone or one only. But there are other clues; for besides that given by overtones, which in accordance with the resonance hypothesis the ear might make use of, viz. (*a*) if there were beats, due to the two instruments not being exactly in tune, the observer might infer that two were sounding, and not one; (*b*) if the sound-waves from one instrument reached the observer's right ear a little earlier (or later) than they reached his left, whereas those from the other instrument had different time relationships, he might infer that there were two sources of sound, from the observation that the two sources did not occupy the same position relative to his own plane of symmetry; and (*c*) if the sounds from the two instruments did not begin and end together the observer might get information from this also. All these possible methods of observation are compatible with the resonance theory, and therefore it is quite unnecessary to assume that the ear must be able to perform an analysis which is not in accordance with Fourier's theorem. It seems to me, therefore, that Dr. Perrett's objection must fail on all the above grounds.

May I take this opportunity of describing a fresh piece of evidence in favour of the resonance theory? Helmholtz showed, from physical considerations, that the coefficient of "sharpness of tuning" should be inversely proportional to the "persistence" coefficient in the case of resonators responding to tones of different pitch. This relationship does not postulate any special form of resonator, but appears to be a general rule equally as applicable to an electrical oscillating circuit as to a stretched string. If, then, it could be shown that the ear obeys this rule, it would be presumably very strong evidence indeed for the existence of resonators in the cochlea. The following table, calculated from observations by Mayer (published in *Amer. Journ. Sci.*, January, 1894), shows that the necessary evidence exists:—

A Mean tone in vibs. per sec.	B Per cent. difference of tone required to stop disonance (tuning factor)	C No. of vibrations performed during a subliminal silent interval (persistence factor)	B×C Tuning factor multiplied by persistence factor.
128	12·70	1·78	22·6
256	10·00	2·06	20·6
320	9·45	2·19	20·8
384	9·07	2·18	19·8
512	8·45	2·37	20·0
640	8·15	2·54	20·7
760	7·82	2·68	21·0
1024	7·22	3·01	21·7

Since multiplying tuning factor by persistence factor gives values nearly constant for different resonators (the average error is less than 3 per cent.), as shown in the last column in the above table, the tuning coefficient must be very nearly inversely proportional to the persistence coefficient. That is, the ear behaves quantitatively as it ought to do if it contained resonators.

I find a correction is necessary in my letter to NATURE of January 5. "Tide production" on line 20 should read "tide prediction." H. HARTRIDGE.

King's College, Cambridge.

A Curious Physiological Phenomenon.

IN Prof. Graham Brown's comments in NATURE of December 22 last on the letter with the above title, he points out that "the peculiarity of the present movement is that it is in the same direction as the original one." In this it resembles the sensory phenomena of positive optical after-images. Now these are periodically repeated after fairly strong stimulation, and it seemed worth while to look for such repetition in the present case. This is easily found, merely by increasing the time during which the hand is pressed against the wall up to about a minute until the whole arm feels tired. The rise and fall described occurs as usual; after a brief pause the arm again rises somewhat less vigorously, and a third much weaker rise may follow. This succession of movements does not always occur. In fact, in my own case even the first rise occasionally fails for no apparent reason.

I have found these repeated movements in the cases of colleagues who were not informed in any way what to expect. I am not familiar with the physiological theory of fatigue, but to a physicist these alternations of rest and activity inevitably suggest the accumulation and discharge of potential energy. I do not know if physiologists can find place for a (? cerebral) mechanism by which a thwarted stimulus can store up "strain" energy of appropriate kind, which after a brief interval is discharged by fulfilling its particular motor or sensory function. Further accumulation and discharge might follow, something after the fashion of the successive residual charges and discharges of a Leyden jar.

If this be so, positive visual after-images may have a similar origin. As is well known, the intensity of sensations only increases by equal increments when the exciting stimuli increase by equal ratios; thus strong stimuli fail, so to speak, to produce their full effect; there is inhibition and perhaps a storing of "strain" energy. Afterwards liberated, may this give rise in the sensory case to after-images, or with motor mechanisms to these involuntary muscular movements?

It may be added that the phenomenon can be produced in the leg by standing on one foot and pressing the outer side of the other against a wall, then allowing the leg to fall to the vertical with the foot still clear of the ground; after a short pause the leg rises laterally again. Or if the lower leg is drawn back so that its calf (or Achilles tendon) presses upwards and backwards against the edge of a heavy chair, and is then allowed to fall, the knee involuntarily flexes again after a very brief interval. In this case there is (with me, at any rate) a strong tendency for the pressure against the chair to cause acute cramp in the biceps muscle of the thigh.

J. H. SHAXBY.

Viriamu Jones Physical Laboratory,
University College, Cardiff, December 30.

Structures and Habits Associated with Courtship.

MR. JULIAN HUXLEY'S letter in NATURE of December 29 last upon the habits of courtship brings to notice some of the recently ascertained facts. From these he concludes that the conspicuous colours, patterns, and forms made use of in these displays and ceremonies resemble copulatory organs in being subservient to efficiency in securing union of the gametes, and that, therefore, the problem of their evolutionary origin is much simplified and similar to adaptive characters in general.

However, the argument that because they are thus used they are therefore adaptations for the purpose of producing sexual excitement is not justified. It may well be that each animal for display makes use of a bright coloration or conspicuous structure of which the evolutionary origin is governed by some other factor. The dog uses its hind limb to scratch its back, but who would say that back-scratching controls its evolutionary origin?

The fact that polygamy is especially associated with brilliant males, whilst in polyandry females are usually the more highly coloured sex, clearly shows that some other factor governs the evolutionary origin of these secondary sexual differences.

A few other antagonistic facts may be mentioned. In birds it is the rule for the sexes to be similar when they both take part in the rearing of the young, as in the partridge; whereas when the male takes no part, as in ducks, secondary sexual differences are common.

In relatively unpalatable animals the sexes are usually similar, whereas it is in palatable animals that the greatest secondary sexual differences are to be found. Butterflies and birds especially exhibit this distribution.

In predatory animals it is the rule for the sexes to be alike. Instances of differences in coloration between young and adults exactly similar to the secondary sexual differences are widely distributed in birds. Further special difficulties arise in the case of insects, in view of their low visual acuity and poor colour perception which probably precludes the female from ever seeing the colour and pattern of the male. Further, the study of their courtship shows that scent and motion (which tends to conceal colour and pattern) are the means chiefly used to promote sexual excitement.

It is generally agreed that destructive criticism should be accompanied by some alternative explanation, but columns for correspondence do not permit of lengthy expositions. I would, however, offer the explanation that the distribution of secondary sexual colorations is related to the vision of preyer and preyed-upon and the necessity especially to protect the female even at the expense of the male. This thesis is fully expanded in J. C. Mottram's "Controlled Natural Selection" (Longmans, Green and Co., 1914).

J. C. MOTTRAM.

Radium Institute, Riding House Street,
London, W.

Spontaneous Ignition of Peaty Soils.

I OBSERVE in NATURE of August 25 last (p. 811), which has just reached me, a letter by Mr. E. A. Martin entitled "The Generation of Heath Fires," in which the spontaneous ignition of peaty soils brought about by exposure to the direct rays of the sun is mentioned.

It may be of interest to remark that in this part of the world such examples of ignition of peaty soils are quite common when the soils, in addition to being exposed to the heat of the sun, are brought into a condition of extreme drought.

In certain parts of Cachar and Sylhet, where the conformation of the land is that of a series of rounded hillocks with intervening depressions, the depressions are filled with peaty deposits, often of considerable depth, known locally as "bheels." These bheels have been formed in the usual manner by the continued growth of vegetation in a place where water accumulates, and in the ordinary course of events are always waterlogged.

Many of the bheels have been brought into cultivation and planted with tea, and one of the greatest problems in connection with the cultivation of these areas has been the removal of the enormous amount of water which accumulates in such places during the rainy season, for, in addition to the fact that more than 100 in. of rain may fall on the area in the course of five months, much of the drainage-water from the surrounding hillocks finds its way into the bheels. To this end it has been a common practice to dig an exceedingly wide and deep drain along the lowest part of the bheel, which is generally near the centre, and to drain into this from the edges. In this way the excess water is got rid of in the rainy season, but there has been an attendant disadvantage, in that the bheels are often dried out completely during the dry season. This occurs to such an extent that the crop-yielding period is often unduly shortened, and in many places it is a common practice to block up the mouths of the drains at the end of the rains to prevent excessive drying-out and prolong the period of yield.

Further, during the dry period the bushes are pruned and the land hoed clean, and the area thus loses its protective covering of foliage and weeds.

In such circumstances, in which the dried-out area is fully exposed to the sun's rays, spontaneous combustion in the soil is of common occurrence, and the soil becomes uncomfortably hot to walk on even in heavy boots.

Many acres of tea have been killed out in this way, but no ignition of the bushes occurs above ground, and it is questionable if jungle fires ever originate in this way, for it is only in the exceptional circumstances outlined above that the phenomenon has been found to occur.

E. A. ANDREWS.

Indian Tea Association, Tocklai Experimental Station, Cinnamara, Assam, December 14.

Microscope Illumination and Fatigue.

MR. BARNARD's letter in NATURE of December 29 last, p. 566, is unusually dogmatic as a contribution to a scientific discussion. As the title of this correspondence indicates, the original letter was written, not so much to direct attention to a particular method as to a general principle, with the intention of increasing the comfort of workers who have to work long hours at the microscope. It appears that Mr. Barnard has arrived at the same principle independently, but in a case of this nature there is no excuse for withholding from publication a matter which affects the well-being of a large number of workers.

Mr. Barnard condemns the method employed, but perhaps without having given the system described an unprejudiced trial. The ultimate test of any method lies in actual practice. Before publication the resistance-controlled illumination was tested out completely within the limits stated, imposed by the use of light-filters and the nature of the work of this laboratory. Since Mr. Barnard brought up the question of the shift of the dominant radiation—which was irrelevant at the time—further tests have been made with the unscreened light (which is never used for critical work here), and it was found that there was no perceptible loss of resolution or colour differentiation with the lowering of the current. The shift of the dominant is thus not a cause for alarm. A further test showed that to produce equivalent results with neutral filters some eight or ten screens would have to be made, and even then the optimum for every small variation of staining or thickness of section could not be obtained. Such an outfit, with the large amount of experiment and adjustment necessary to get the screens even approximately right, would be quite out of reach of most workers, and could not be conveniently standardised. Further troubles enter with small alterations in the light source due to age and variation of voltage, the general illumination of the laboratory, and, not least, the personal equation.

H. J. DENHAM.

Shirley Institute, Didsbury, January 4.

Tin Plague and Arctic Relics.

REFERRING to the letter on tin plague in NATURE of December 15 last, it may be of interest to record that in the Museum of Fisheries and Shipping at Hull, among a number of Arctic and Antarctic relics, we have two tins, each about 6 in. in diameter, provided with a thin iron handle on the top soldered on to assist in carrying. These tins, according to the "Guide to the Museum of the Hull Literary and Philosophical Society," published in 1860, and confirmed by that society's minutes, were picked up, among other relics and stores left by Capt. Parry, on Fury Beach in 1825. They were found by Capt. (afterwards Sir John) Ross in 1831, who brought them away with him. Capt. Ross was picked up at sea in a boat by Capt. Humphreys, of the *Isabella*, a whaler of Hull, in 1833, and these relics, among others, were in the boat with him. They were brought to Hull and given to the Literary and Philosophical Society. Eventually this society's collection was handed to the Hull Corporation.

About ten years ago I was curious to know the contents of these two tins, and had them opened; one was found to be full of corned beef in excellent colour and condition, and the other contained pea-soup. Both seemed to be quite fresh, and my attendant sampled them and stated that they were quite good and sweet. He still lives. The soup and the meat are now exhibited in glass jars, and are still in good condition.

My object in mentioning these facts is to show that after being left in the Arctic between 1825–31, and then taken charge of for another two years by Capt. Ross, which means that they were more or less subject to Arctic conditions for eight years, and then having been in Hull for eighty years, the metal does not seem to have deteriorated in any way and it had had no effect upon the contents. Possibly this may be due to the fact that the tins were painted with a thick coat of yellow and green paint respectively, which may have prevented any "plague." If this is the cause, the circumstances may be of value on future expeditions of this character.

The Museum, Hull. T. SHEPPARD.

Inheritance of a Cheek-Mole.

PERHAPS the following case of the inheritance of a mole on the cheek for three generations may be interesting. Records do not go back any further, but, as the representative of the present generation is nineteen, it may be possible to see whether it is continued. The grandfather had a peculiar mole right in the middle of his left cheek. Of his children, two daughters both showed it in almost the same position. The sons did not, but one daughter of one son now has it. There are two boys and two girls in family, but it has appeared only on one girl.

G. W. HARRIS.

The Royal Automobile Club, London, S.W.1, December 25.

War Against Insects.[1]

By DR. L. O. HOWARD.

COUNT KORZYBSKI, in his recent remarkable book, "The Manhood of Humanity," gives a new definition of man, departing from the purely biological concept, on one hand, and from the mythological-biological-philosophical idea on the other, and concludes that humanity is set apart from other things that exist on this globe by its *time-binding* faculty, power, or capacity. This is another way of saying that man preserves the history of the race and should be able to profit by a knowledge of the past in order to improve the future. It is, indeed, this *time-binding* capacity which is the principal asset of humanity, and this alone would make the human species the dominant type of the vertebrate series. But, biologically speaking, there is another class of animals which, without developing the *time-binding* faculty, has carried the evolution of instinct to an extreme, and has in its turn come to be the dominant type of another great series, the Articulates, or the Arthropods. As Bouvier puts it,

> Man occupies the highest point in the vertebrate scale, for he breaks the chain of instincts and assures the complete expansion of his intelligence. The insects hold the same dominating position in the Articulates where they are the crowning point of instinctive life.

Unlike the Echinoderms and the Molluscs, which have retained their hard coverings or shells, and have therefore progressed more slowly—for, as Bergson says, "The animal which is shut up in a citadel or a coat of mail is condemned to an existence of half sleep"—Vertebrates, culminating in man, have acquired the bodily structure which, guided in man by the equally acquired intelligence, has enabled him to accomplish the marvels which we see in our daily existence. Moreover, the Articulates have in the course of the ages been modified and perfected in their structure and in their biology until their many appendages have become perfect tools adapted in the most complete way to the needs of the species, until their power of existing and of multiplying enormously under the most extraordinary variety of conditions, of subsisting successfully upon an extraordinary variety of food, has become so perfected and their instincts have become so developed that the culminating type, the insects, has become the most powerful rival of the culminating vertebrate type, man.

Now this is not recognised to the full by people in general—it is not realised by the biologists themselves. We appreciate the fact that agriculture suffers enormously, since insects need our farm products and compel us to share with them. We are just beginning to appreciate that directly and indirectly insects cause a tremendous loss of human life through the diseases that they carry. But apart from these two generalisations we do not realise that insects are working against us in a host of ways, sometimes obviously, more often in unseen ways, and that an enormous fight is on our hands.

It is difficult to understand the long-time comparative indifference of the human species to the insect danger, but even during the active lifetime of the speaker there has come a change. Good men, men of sound laboratory training, have found themselves able in increasing numbers, through college and Government support, to devote themselves to the study of insect life with the main end in view of controlling those forms inimical to humanity, and to-day the man in the street realises neither the number of trained men and institutions engaged in this work nor the breadth and importance of their results, not only in the practical affairs of life, but also in the broad field of biological research. The Governments of the different countries are supporting this work in a manner that would have been considered incredible even five and twenty years ago, and this is especially true of the United States and Canada, and scarcely less so of France, Italy, Japan, South Africa, and, at least until four years ago, Russia.

It may be worth while here, however, to point out that certain European countries are combining their studies of agricultural entomology and crop diseases under the term phytopathological studies, or an Epiphyte Service (*Service des Epiphyties*), as in France, and this is undesirable, since it obscures to a certain extent the great issue of insect warfare and divides the great field of economic entomology in a most unfortunate way. Let us hope that the movement will not grow. Let the entomologists co-operate with the pathologists, both plant and animal, wherever there is something to be gained by such co-operation, but let us keep the respective fields entirely clear.

The war against insects has, in fact, become a world-wide movement which is rapidly making an impression in many ways. Take the United States, for example, where investigations in this field are, for the time being, receiving generous Government support. Every State has its corps of expert workers and investigators. The Federal Government employs a force of four hundred trained men and equips and supports more than eighty field laboratories scattered over the whole country at especially advantageous centres for especial investigations. Also there are teachers in the colleges and universities, especially the colleges of agriculture, who are training workers in insect biology and morphology and in applied entomology both agricultural and medical.

[1] Abridged from the presidential address to the American Association for the Advancement of Science delivered on December 27, 1921, at Toronto.

All this means that we are beginning to realise that insects are our most important rivals in Nature, and that we are beginning to develop our defence.

While it is true that we are *beginning* this development, it is equally true that we are only at the start. Looking at it in a broad way, we must go deeply into insect physiology and minute anatomy; we must study and secure a most perfect knowledge of all of the infinite varieties of individual development from the germ cell to the adult form; we must study all of the aspects of insect behaviour and their responses to all sorts of stimuli—their tropisms of all kinds; we must study the tremendous complex of natural control, involving as it does a consideration of meteorology, climatology, botany, plant physiology, and all the operations of animal and vegetable parasitism as they affect the Insecta. We must go down to great big fundamentals.

All this will involve the labours of an army of patient investigators and will occupy very many years—possibly all time to come. But the problem in many of its manifestations is a pressing and immediate one. That is why we are using a chemical means of warfare, by spraying our crops with chemical compounds and fumigating our citrus orchards and mills and warehouses with other chemical compounds, and are developing mechanical means both for utilising these chemical means and for independent action. There is much room for investigation here. We have only a few simple and effective insecticides. Among the inorganic compounds we have the arsenates, the lime and sulphur sprays, and recently the fluorides have been coming in. Of the organic substances we use such plant material as the poisons of hellebore and larkspur, pyrethrum and nicotine; and the cyanides and the petroleum emulsions are also very extensively used. No really synthetic organic substances have come into use. Here is a great field for future work. Some of the after happenings of the war have been the use of the army flame-throwers against the swarms of locusts in the South of France, the experimental use against insects of certain of the war gases, and the use of the aeroplane in reconnaissance in the course of the pink bollworm work along the Rio Grande, in the location of beetle-damaged timber in the forests of the North-west, and even in the insecticidal dusting of dense tree growth in Ohio. The chemists and the entomologists, working co-operatively, have many valuable discoveries yet to make, and they will surely come.

All this sort of work goes for immediate relief. Our studies of natural control follow next. It is fortunately true that there are thousands upon thousands of species of insects which live at the expense of those that are inimical to man and destroy them in vast numbers; in fact, as a distinguished physicist, in discussing this topic with me, recently said: "If they would quit fighting among themselves they would overwhelm the whole vertebrate series." This is, in fact, one of the most important elements in natural control, and is being studied in its many phases by a small but earnest group of workers.

So far, while we have done some striking things in our efforts at biological control, by importing from one country into another the natural enemies of an injurious species which had itself been accidentally introduced, and while we have in some cases secured relief by variations in farm practice or in farm management based upon an intimate knowledge of the biology of certain crop pests, we are only touching the border of the possibilities of natural control. For an understanding of these possibilities we must await the prosecution of long studies.

Let us summarise. Few people realise the critical situation which exists at the present time. Men and nations have always struggled among themselves. War has seemed to be a necessity growing out of the ambition of the human race. It is too much, perhaps, to hope that the lesson which the world learned in the years 1914 to 1918 will be strong enough to prevent the recurrence of international war; but, at all events, there is a war, not among human beings, but between all humanity and certain forces that are arrayed against it. Man is the dominant type on this terrestrial body; he has overcome most opposing animate forces; he has subdued or turned to his own use nearly all kinds of living creatures. There still remain, however, the bacteria and protozoa that carry disease and the enormous forces of injurious insects which attack him from every point and constitute to-day his greatest rivals in the control of Nature. They threaten his life daily; they shorten his food supplies, both in his crops while they are growing, and in such supplies after they are harvested and stored, in his meat animals, in his comfort, in his clothing, in his habitations, and in countless other ways. In many ways they are better fitted for existence on this earth than he is. They constitute a much older geological type, and it is a type which had persisted for countless years before he made his appearance, and this persistence has been due to characteristics which he does not possess and cannot acquire—rapidity of multiplication, power of concealment, a defensive armour, and many other factors. With all this in view it will be necessary for the human species to bring the great group of insects under control, and to do this will demand the services of skilled biologists—thousands of them. We have ignored the insect group to a certain extent on account of the small size of its members, but their small size is one of the great elements of danger—is one of the great factors of their success in existence and multiplication.

Let all the departments of biology in our universities and colleges consider this plain statement of the situation, and let them begin a concerted movement to train the men who are needed in this defensive and offensive campaign.

What the Public Wants.

A STUDY OF THE AMERICAN MUSEUM OF NATURAL HISTORY.

THE American Museum of Natural History probably stands at the head of those museums which set out to interest and attract the general public. In so doing it obeys the clauses of its Acts of Incorporation, but it obeys also the more imperative law of its continued life: to live, a museum, like everything else, must progress; to progress, it needs sustenance. The American Museum, being neither a Government museum, nor a State museum, nor a municipal museum, has to rely upon private endowment and subscriptions. The annual appropriation of the city is confined to the maintenance of the building, and is inadequate even for that purpose. To instal its exhibits, to send out its expeditions, to pay its staff, and to prosecute those scientific researches for which it is celebrated, the museum must arouse private individuals to that degree of enthusiasm at which they will part with their dollars. The mechanism is the enrolment of such individuals as members of various grades, and so successful is it that no less than 5556 members are now enrolled.

Of the numerous ways in which the museum appeals to this great public, and to the far greater public as yet only on the road to membership, we can mention here a bare selection. The most obvious, and the most characteristically a museum method, is the preparation of popular exhibits. The example set by our own Natural History Museum has here been left far behind. The present report furnishes two illustrations, which we are permitted to reproduce. Fig. 1 shows part of a group of the northern elephant seal, from a colony recently discovered on the island of Guadalupe. A small portion of the new Bryozoa group, which represents two square inches of sea-bottom magnified twenty-five diameters, is depicted on two-thirds that scale in Fig. 2. Groups of this latter kind, based on prolonged studies, and carried out with extreme technical skill, are among the most instructive, as well as the most fascinating, novelties. Then there are the larger series, such as the exhibit of the natural history of (modern civilised) man, projected by the Department of Public Health. We in England have done something in this direction, as witness the exhibits of food, of human parasites, and the biology of water-works at the Natural History Museum, but we have not formulated the conception of man in relation to his whole environment of to-day. Temporary exhibitions are useful as keeping a museum alive and attracting fresh sections of the public. Dr. Lucas, the director, does not favour the expenditure of curatorial energy on these, but when they are installed by outside bodies, as the wireless telephone display or the posters teaching kindness to animals, it is only space that he grudges. During 1920 all this activity in the exhibition galleries attracted

FIG. 1.—California sea-elephant group. By the courtesy of the American Museum of Natural History, New York.

937,265 visits (exclusive of attendance on lectures), which compares favourably with the corresponding totals of 851,483 at the British Museum (Bloomsbury), and 527,701 at the British Museum (Natural History).

This number, however, does not represent half the people reached by the popularising and educational work of the American Museum. Forty-eight societies have been welcome to hold meetings, exhibits, or lectures in the meeting-rooms of the museum during the year. Lectures have been given to school children and adults by a special department of public education co-operating with the City Board of Education. This increases the number of visits by 100,750. This department also carries its lectures to the schools themselves, lends lantern-slides by myriads, and circulates 887 special col-

lections among schools and libraries. The number of pupils reached by this outside work cannot be less than a million.

To this direct appeal of the museum specimens the publications are supplementary. Confining our attention to those of educational character, we find, as elsewhere, guides, handbooks, and leaflets, for use primarily in the museum. But reaching far beyond its walls is the well-known Journal of the museum, now issued as a bi-monthly under the title *Natural History*. A copy of this is received by every member, and additional subscriptions amount to 1,570 dollars. The circulation may therefore be taken as well over 6000. Besides its own publications, the American Museum avails itself of the newspaper Press, and by the steady contribution of interesting paragraphs obtains valuable advertisement.

FIG. 2.—Bryozoa group: detail. By the courtesy of the American Museum of Natural History, New York.

We have by no means finished with the ways in which the American Museum increases its membership and otherwise raises its funds. There is, for example, the luxuriously furnished members' room "near the elevator" (Natural History Museum, please note!), and there is the exchange of membership privileges with other museums. But enough has been said to show that all the energy is spent on lines that are productive, and that fact explains how it can be done. In the larger cities of our own country circumstances are not the same. There are limited appropriations for definite purposes, and the governing body, whether municipal or bureaucratic, is not going to take risks with the taxpayers' money. Possibly some of our museum officials rejoice that they do not have to spend their time beating the big drum, and prefer to devote most of their energy and the services of their museums to the advancement of learning rather than to its vulgarisation. Research, they say quite rightly, must come first. None the less, there are features in the educational work of the American Museum which could and should be imitated by more of our Government museums. With them, as with the private corporation of the American Museum, the question reduces itself to one of business. Additional officers must be appointed in charge of these activities, and these officers must be paid. But the public is ready to pay for what it wants, and the case of the guide-lecturers has shown that the Government will respond to intelligently directed and strongly enforced public opinion

Obituary.

DR. EDWARD HOPKINSON, M.P.

THE news of the death of Edward Hopkinson will be received with acute regret by a very wide circle of friends in all branches of science and engineering. Since the General Election of 1918, when Dr. Hopkinson became Member for the Clayton division of Manchester as a Unionist, he was the victim of repeated attacks of influenza, for want of a better name, and was little seen in London; gradually failing, he died on Sunday, January 15, at the age of sixty-two years.

Dr. Hopkinson was the fourth among five sons in a Manchester family, peculiarly united and brilliant, belonging to an aristocracy of industry. His father, John Hopkinson, sometime Mayor of Manchester, was of the firm of Wren and Hopkinson, mechanical engineers, who constructed the machinery for grinding the glass for Chance's lighthouses, a successful demonstration of science and higher industry. His mother, always the true focus of the family, was a Dewhurst of Skipton. The Wills's of Bristol were relatives. The eldest brother, John, the great electrician, whose work was cut short by his untimely death in the Alps, is nobly commemorated in Cambridge; he started on his work as Senior Wrangler. The next brother, Sir Alfred Hopkinson, K.C., of Lincoln College, Oxford, formerly a Member of Parliament for a division of Manchester and for the Cricklade division of Wiltshire, who is still active, had a distinguished legal career, was principal of Owens College, and first vice-chancellor of the University of Manchester. The third son, Charles, a consulting engineer, who died recently, was the trusted counsellor of the whole family. Albert, the youngest brother, of Emmanuel College, Cambridge, became a successful medical practitioner in Manchester, and is now back again in Cambridge as a teacher of anatomy. Of the next generation, Bertram, the lamented head of the Engineering School at Cambridge, lost his life in a flying accident in 1918, and Austin, a successful manufacturer and M.P., is a very vigorous controversialist in social questions. These different distinctions merely represent prominences of characteristics which all shared.

Edward Hopkinson was born in Manchester, and, after completing the course at Owens College, joined Emmanuel College, Cambridge, as scholar,

was ninth Wrangler in 1881, and D.Sc. of London in the same year. He became a fellow of Emmanuel in 1883. He began his fellowship by installing electric light in the hall and chapel for the tercentenary of the college in the following year, and thus anticipated by a few weeks the installation which Lord Kelvin introduced into Peterhouse. He was first with Siemens Brothers, and was resident electrician for the Portrush and Bushmills Railway and the Bessbrook and Newry Railway. He afterwards joined the firm of Mather and Platt when they began electrical work, and ultimately became vice-chairman of the company. He carried out the scheme for the City and South London Railway, and while engaged upon industrial work of that kind he joined his brother John in a paper on dynamo-electric machines in the Transactions of the Royal Society, a paper which speedily became classical. Thereafter he was engaged in electrical and engineering work which brought him into contact with all the active electrical and engineering experts of the country. During the war he was engaged in India on the Indian Industrial Commission. He was president of the Institution of Mechanical Engineers in 1919, but not well enough to deliver the presidential address which he wrote for that body.

Electricity and machinery were not Dr. Hopkinson's only interest; like other members of his family, he was deeply and sanely interested in social questions, and his latest writings are to be found in letters to the *Times* and *Morning Post* on financial matters. Like all the rest of his family, too, he was a keen Alpine climber and member of the Alpine Club, and, like so many climbers, was a remarkably genial host and an ever-welcome guest. He lived in an atmosphere of business, science, and common sense, to which access was easy on account of his family associations; but he contributed his own full share to its maintenance, and the loss of his knowledge and experience is a grave misfortune. He and his brother Charles married sisters, the daughters of John Campbell, of Whiteabbey, near Belfast. His wife survives him. They have one son, formerly an officer in the Army, who is now devoted to anthropology at Cambridge, and a daughter.

NAPIER SHAW.

SIR WILLIAM MATTHEWS, K.C.M.G.

THE civil engineering profession has lost an eminent personality by the decease of Sir William Matthews, who died on January 8 at the age of seventy-eight. From the obscurity of a little Cornish town he rose in the practice of his profession to become the trusted consultant of Government authorities on the most important harbour undertakings in the Empire. His name will long be associated with the annals of harbour construction, and substantial breakwaters in various parts of the world remain as a testimony to his engineering skill. The firm of Coode, Matthews, Fitzmaurice, and Wilson, of which he was until lately the senior surviving partner, have acted as technical advisers to the Admiralty, the Board of Trade, and the Crown agents to the Colonies. At home they were chief engineers for the National Harbour at Dover; abroad they have been consulting engineers for similar undertakings at Gibraltar, Malta, Cyprus, Colombo, Singapore, and Hong-Kong. They are also consultants to several Colonial Governments, the Mersey Conservancy, the Humber Conservancy, and the Tyne Commissioners.

Sir William Matthews was a native of Penzance, where he was born in March, 1844. He served part of his apprenticeship in an engineering works at Hayle, a few miles away. Afterwards he entered the office of his father, who practised as a civil engineer in Penzance. There in 1864 he came under the notice of the late Sir John Coode, who had been called in to advise the Corporation of Penzance. The young assistant was employed to make a survey of the harbour, and acquitted himself so creditably that Sir John took him into his office in London, and ultimately in 1892 into partnership.

The value of Sir William Matthews's services to the Government gained him the C.M.G. in 1901, and the K.C.M.G. in 1906. In 1907 he was elected president of the Institution of Civil Engineers. He became a member of the International Commission on the Suez Canal in 1908, and during the later portion of his career served on a number of committees of public and scientific utility.

COL. CHARLES EDWARD CASSAL, who died on December 22 last, in his sixty-fourth year, was public analyst for the Metropolitan Borough of Battersea, the Royal Borough of Kensington, the Parts of Holland and Kesteven (Lincs), and Chipping Wycombe (Bucks), and joint public analyst for the City of Westminster. He was educated at University College School, and received his professional training at University College, London, where he was demonstrator in the department of hygiene and public health from 1879 to 1888. He was a fluent and forcible speaker, and, having qualified, by examination, for the fellowship of the Institute of Chemistry, he took a prominent part in the discussions relating to the interests of his profession, particularly those of public analysts and official agricultural analysts. Col. Cassal served on the council for six periods of three years each, and as a censor for one year. He frequently accompanied deputations from the institute to Government departments. For fifteen years he was editor of the *British Food Journal*, to which, as well as to other journals, he contributed many articles on the chemistry of food and drugs, on water supplies, and on sewage treatment and disposal.

WE regret to have to record the death of MR. B. P. LASCELLES, who was a science master at Harrow from 1885 to 1901. His great success as a teacher rested on his unbounded interest in everything which appealed to him. It was not enough for him to know about dyes; he made them and coloured his own ties to his fancy! That was in the early days of the synthetic industry. Such

interest is contagious, and so he firmly established the Harrow Scientific Society, as he had helped to found the Junior Scientific Society at Oxford. Though a chemist by training—he was a fellow of the Chemical Society—his activities were at least as wide as those of the British Association, of which he was a keen supporter. His knowledge of palæontology and of archæology was deep. Few indeed were the branches of learning along which he could not guide a young inquirer, so he fulfilled perfectly the offices of librarian and curator of the school museum. The municipal life of his adopted town and county owe much to Mr. Lascelles, whose many friends will ever remember his genial personality with gratitude.

PROF. W. FOORD-KELCEY, professor of mathematics at the Royal Military Academy, Woolwich, since 1903, died on January 3 at the age of sixty-seven. He was a scholar of Exeter College, Oxford, and obtained a First Class in the Final Mathematical School in 1877. He joined the Royal Military Academy as instructor in mathematics in 1878; later he was called to the Bar, and for a time combined legal work with teaching, but eventually gave up the former. Altogether, Prof. Foord-Kelcey was at the Academy for forty-three and a half years, and nearly all serving gunner and sapper officers knew him. He was a man of great ability with brain, hand, and eye, being a first-rate practical mechanic. He had a wide knowledge of mechanism, and retained his interest in the teaching of mechanics to the last. He was due to retire in the summer of this year, and in him the Royal Military Academy has lost a great personality.

FATHER GIUSEPPE LAIS, S.J., whose death in Rome was recently announced, was born in Rome in 1845. He was the author of a very long series of papers dealing with meteorology, both mediæval and modern, solar eclipses, comets and meteors, and astronomical photography. He published some little-known meteorological records of the sixteenth and seventeenth centuries. He took a deep interest in the astrographic chart, and published researches on the best methods of measuring and developing the plates. As vice-director of the Vatican Observatory since 1903 he has had a large share in taking the plates of the zone allotted to that observatory. He was also interested in the question of calendar reform, publishing papers on this subject in 1892 and 1901. Father Lais was for many years vice-secretary of the Accademia dei Nuovi Lincei, Rome.

WE regret to announce the death on January 15, in his ninetieth year, of SIR JOHN KIRK, G.C.M.G., K.C.B., F.R.S., chief officer and naturalist of Livingstone's expedition to the Zambezi in 1858–63, during which he made large collections and many observations of great scientific value. He was the author of numerous contributions to the botany, zoology, and geography of Eastern tropical Africa.

WE regret to see the announcement of the death on January 8, at eighty-six years of age, of PROF. J. H. COTTERILL, F.R.S., formerly professor of applied mechanics, Royal Naval College, Greenwich.

Notes.

THE gold medal of the Royal Astronomical Society has been awarded to Dr. J. H. Jeans for his contributions to theories of cosmogony.

M. RAYMOND POINCARÉ, who has succeeded M. Briand as Prime Minister of France, held that office in the years 1911–13, and was President of the French Republic in 1913–20. He is a brother of M. Lucien Poincaré, the distinguished official head of the University of Paris, who died nearly two years ago, and a cousin of the great mathematician and philosopher, Prof. Henri Poincaré, who died in 1912. In 1914 M. Poincaré was elected Lord Rector of the University of Glasgow, and in November, 1919, he delivered an inspiring address on Franco-Scottish unity to an assembly of four thousand students and other members and friends of the University.

THE Strangers' Hall, Norwich, an interesting old city merchant's house, with groined undercroft, fifteenth-century banqueting hall, and other panelled rooms of later date, has been offered by its owner, Mr. Leonard G. Bolingbroke, to the Corporation of Norwich for the purpose of an English Folk and Historical Museum, in conjunction with the Norwich Castle Museum. Mr. Bolingbroke has also offered his collection of old domestic appliances and other "bygones" illustrative of the various phases of a middle-class Englishman's home during the last four or five centuries, which will find a fitting environment in the various rooms of the house. While the aim of the museum will be historical rather than scientific, there will be found many exhibits of interest to students of the early history and development of such subjects as the production of light and fire, domestic cookery, and other kindred objects.

THE annual meeting of the Institute of Metals will be held in London on March 8–9, when ten important papers are to be presented for discussion. The annual May lecture will be delivered on May 3 by Sir Ernest Rutherford on "The Relation of the Elements." The autumn meeting will be held at Swansea on September 20–22. A large gathering is expected in this important metallurgical centre, and the Mayor and corporation have extended a very hearty invitation to members of the institute. Last year the membership of the institute increased from 1298 to 1410—a record year's growth. Such an increase, occuring during a year of great trade depression, indicates that makers and users of non-ferrous metals and alloys are on the alert to take advantage of the

scientific information obtainable through association with the institute that exists to foster their interests. It is largely through the adoption of more scientific methods of manufacture that the British manufacturer will be able successfully to meet foreign competition, and it is just here that invaluable service is being rendered by our scientific institutions.

THE officers of the Ramsay Memorial Fund announce that the Dean and Chapter of Westminster have consented that a tablet containing a medallion portrait of Sir William Ramsay should be placed in Westminster Abbey in the place immediately below that occupied by the Hooker tablet. The tablet is being executed by Mr. Charles Hartwell, A.R.A. It is anticipated that the unveiling will take place in October next. An announcement will be made on the subject in due course. At the request of the Ramsay Memorial Committee a commemorative medal of the late Sir William Ramsay has been executed by the distinguished French sculptor, M. Louis Bottée. The medals will be struck shortly in London when it is known approximately how many will be required.

ON January 2 occurred the centenary of the birth of Rudolf Julius Emmanuel Clausius, the distinguished mathematical physicist and the predecessor of Hertz in the chair of natural philosophy at Bonn. The son of a pastor and schoolmaster, Clausius was born at Koslin, in Pomerania, and after attending the gymnasium at Stettin, spent four years at Berlin, where he studied under Dirichlet, Steiner, Dove, and Magnus. Before going to Bonn he held appointments at the Royal Artillery School, Berlin, Zürich Polytechnic, and Würzburg University. Recognised as one of the founders of the science of thermo-dynamics, it was in his memoir to the Berlin Academy of Sciences in 1850 that he re-stated Carnot's principle in its correct form. To him is also due the conception of entropy. His chief work, "Die Mechanische Wärmetheorie," appeared in 1867. The kinetic theory of gases and the theory of electrolysis also owed much to his labours. Among his honours was that of the receipt of the Copley medal, while the Institution of Civil Engineers made him an honorary member. He was called to Bonn in 1869, served as Rector of the University during 1884–85, and died there on August 24, 1888.

IN his presidential address to the American Association for the Advancement of Science, delivered in December last at Toronto, Dr. L. O. Howard made some interesting remarks on the ages of presidents of the British and American Associations. The average age of the presidents of the British Association during the period 1895–1920 was sixty-one years and eleven months, and of those of the American Association sixty-one years and five months. The youngest president of the British Association during that period was fifty-three years of age, and Sir A. W. Rucker (1901), Sir J. J. Thomson (1909), and Prof. W. Bateson (1914) were each fifty-three years of age when serving as president. The oldest was Prof. T. G. Bonney (1910), whose address was delivered at the age of seventy-seven. The youngest of the American presidents were Minot and Richards, whose addresses were delivered at the age of fifty; and the oldest was Eliot, whose Philadelphia address was delivered when he was seventy-nine years of age. "We may safely assume," remarks Dr. Howard, "that the usefulness of the man past middle age is granted, and that, while he may not have the illuminative bursts of inventive or speculative genius which come to the younger man, he is better able to make the broad generalisations based upon accumulated experience—in other words, to prepare an appropriate presidential address as president of the British or the American Association for the Advancement of Science."

AT the Institution of Electrical Engineers on January 12 there was an interesting exhibition of instructive American cinematograph films. The first film, which was exhibited by Dr. Garrard, showed tests of high-tension switchgear. The experiments with switches were made with currents of the order of 100,000 amperes, the object being to find out how the apparatus withstood the enormous mechanical stresses set up by these very large currents. The films were first shown at the ordinary speed; they were then shown at a reduced speed, so that the various effects produced could be followed. The tests made on current and potential transformers showed clearly the types which withstood the stresses best. In some cases switching on the power produced effects similar to those produced by a high-explosive bomb. A noteworthy educational film called "The Audion" was also exhibited. It explained very clearly the operations which are believed to take place between the transmitter and the receiver in radio-telegraphy. The electrons are shown in active motion round the filament of a thermionic tube, and the artist shows by means of them the valve action of the tube. Similarly, the amplifying action of the grid is explained by the motions of the electrons. The currents in the antenna and the waves leaving it were also shown in motion, the whole producing a very lively representation of what takes place. The films were made by the Western Electric Co. of America for the instruction of their employees. Another film showed the building up of a telephone, all the various parts of it slowly and deliberately getting into their proper places apparently by their own agency.

THE annual meeting of the Mathematical Association was held on January 2–3, and Sir T. L. Heath was elected president as successor to the Rev. Canon J. M. Wilson. Papers were read by Sir George Greenhill on "Mathematics and Artillery: Before and After the War: A Review of the Outlook: Then and Now," and on "The Structure of the Atom" by Dr. J. W. Nicholson. Prof. C. Godfrey delivered an address on the importance of the introduction of vectors in the work of the secondary school—a subject on which several writers in the *Mathematical Gazette*

have written strongly of late. Miss F. A. Yeldham's paper on "The Dalton Plan and the Teaching of Mathematics" aroused considerable interest; an animated discussion followed, with many inquiries as to the details of her experiences of the plan as at work in the Streatham schools. Prof. G. H. Hardy gave a most interesting address on the life and work of that Indian genius, the late Srinivasa Ramanujan, which was full of personal recollections. He set forth with consummate skill the nature of Ramanujan's researches, his successes, and his failures. He also made an eloquent appeal for a wide extension of education in India, assuring his audience that with such opportunities for the great peninsula as we enjoy here in the West there would soon be an Indian school of mathematics at least equal to anything that can be shown in Europe or America. Incidentally he condemned the folly of those who have decried the Germans as lacking in originality. The next paper was by Mr. A. Dakin, who pleaded with much effect that pure and applied mathematics should be taught and developed *pari passu* in boys' secondary schools. The meeting was brought to a close with a discussion opened by the Rev. E. M. Radford on the best ways of keeping teachers of mathematics in touch with modern developments and methods—a most important problem, and one for which a solution must be found in the near future.

In an interesting paper contributed to the Journal of the Royal Anthropological Institute (vol. 51, part 1) Prof. F. G. Parsons arrives at conclusions, which may be quoted in his own words, in connection with the Long Barrow race, and its relationship to the modern inhabitants of London. He believes that "the shape of the skull is the result of vital or physiological forces, some of which we grasp feebly, and others which we do not understand at all as yet, acting on it for a very long time; but that shape, once established, is very permanent, and most of its characteristics remain for thousands of years after the race bearing them has changed its habitat. Even when the race has been practically bred out by competing races, better adapted to the changed conditions, all the old characters reappear from time to time, sometimes singly, but occasionally all together." For example, the skull of Jonathan Wild reproduces all the characters of the Long Barrow race. "Finally, I must admit that the skull of the modern twentieth-century Londoner has changed from that of the eighteenth, but it is in the direction of increased breadth and shortness, and the change is due, I believe, to admixture with the Central European or Alpine race, which in the last two centuries has been pouring into this country in ever-increasing quantities."

As stated in NATURE of December 30, 1920 (vol. 106, p. 583), the first Pan-Pacific Scientific Conference resolved that fuller knowledge of the history and culture of the Polynesian race was essential to the solution of the ethnographic problems of the Pacific. The Report of the Director of the Bishop Museum, Honolulu, for 1920, just received, informs us that Mr. Bayard Dominick, of New York, is financing an expedition for the study of Polynesian origin and migration. This is organised by the Bishop Museum in conjunction with authorities from countries bordering on the Pacific. During 1920–21 parties have been stationed on the Marquesas, Austral, Tongan, and Hawaiian Islands to establish standards of physical form, material culture, traditions, and language of the Polynesians. During 1921–22 a boat with a scientific staff is making observations in selected localities along the route Honolulu, Wake, Marshall, Eastern Carolines, Gilbert, Ellice, Samoa, Tonga, Friendly, Cook, and Society Islands, returning to Honolulu *via* Tongareva, Malden, Christmas, and Fanning Islands. The Bishop Museum acts as permanent representative of the first conference. Its director, Prof. H. E. Gregory, is chairman of a committee to arrange for future conferences, and associated with him are E. C. Andrews (Australia), C. M. Fraser (Canada), F. Omori (Japan), Charles Chilton (New Zealand), and T. Wayland Vaughan (United States).

THE latest issue of the *Archiv für Kriminologie* (Bd. 72, Heft 3–4) contains an important article by Prof. W. Ostwald, of Leipzig, entitled "Das System der Kriminologie," in which he attempts a classification of the subject-matter of criminology. He starts from a classification of science as a whole under three main headings: (1) Mathetics, subdivided into logic, mathematics, geometry, and kinematics; (2) energetics, subdivided into mechanics, physics, and chemistry; and (3) biotics, subdivided into physiology, psychology, and sociology. Applying this classification to criminological studies, he arrives at a schedule in which criminology in the more restricted sense falls under sociology, while the contributions of sciences auxiliary to criminology proper, such as criminal anthropology and criminal psychology, fall under the earlier and more general headings. Prof. Ostwald gives an example of the working of his scheme as applied to a large number of titles taken from criminological literature. As an attempt to introduce some sort of order on a logical basis in a subject with a wide scope and a vast literature, this classification will be welcome to students. Its terminology, however, if only for the sake of clearness, needs revision and amplification. As it stands at present the titles of the divisions of the schedule are not sufficiently indicative of their content to be of much practical utility as guides. In addition to Prof. Ostwald's paper, this issue of the *Archiv* contains a number of interesting contributions by prominent criminologists, among the more noteworthy being a long account by J. P. L. Hulst, of Leyden, of a number of cases of necrophilia, an examination by Prof. Allfeld and Prof. von Beling of a proposal put forward by Dr. R. Hindl for the treatment of habitual criminals, and a valuable note by Mr. Arthur Macdonald, of Washington, on the possibility of using police records, particularly records for identification purposes, for the anthropological study of the population.

WE have received the Report of the Bacteriological Section, State Board of Agriculture, U.S.A., for 1920. Much work has been done on the keeping qualities of butters, the decomposition of peat, silage production, bovine infectious abortion, various fermentations, soil and food. For the isolation of the *Bacillus abortus*, the causative organism of infectious abortion, a liver agar medium is recommended with an addition of 1 in 10,000 gentian violet. The medium should have a hydrogen-ion concentration of between 6·6 and 6·4, and the cultivation should be conducted in a closed chamber, in which 10 per cent. of the air is replaced by carbon dioxide.

An account of the brachyuran crabs collected by the American Museum Congo Expedition has been published recently by Miss Mary J. Rathbun (Bull. Amer. Mus. Nat. Hist., vol. 43, pp. 379–474, 30 plates). The collection contains about 3000 specimens belonging to forty-three species, and the large series has enabled the author to define many of the previously known species with greater accuracy. Three of the four species of Callinectes known to occur on the West African coast are well represented in the collection, and details of their systematic characters are given. The author states that the collection of land crabs (Cardisoma), about 120 specimens, serves to demonstrate that certain differences between the African species, *Cardisoma armatum*, and the American species, *Cardisoma guanhumi*, are constant. The river crabs (Potamonidæ) form the most important part of the collection, and are represented by nine species, four of which are new. Notes on the bionomics of these crabs are added by Mr. H. Lang, leader of the expedition.

THE rodents of North America, prairie dogs, ground squirrels, pocket gophers, jack-rabbits, field mice and rats, are responsible for depredations amounting to 100,000,000*l*. a year to field crops, pasturage, and stored products. Mr. W. B. Bell, in the Year-Book of the United States Department of Agriculture for 1920, gives an account of the damage which they do, and of the measures taken to control or eradicate them. The matter was first taken up by the Biological Survey, which devised means both of prevention and cure. By their field operations and by demonstration plots they were able to convince the farmer and stockman of the efficacy of their measures, and in this way they won their co-operation, as well as financial support from the individual States of North America. The work now comprises thoroughly organised aggressive campaigns in sixteen of the Western States. The two chief methods of control are poisoning by strychnine and organised drives, and the methods of prevention include the erection of rodent-proof fencing and the introduction of rat-proof devices into buildings used for storage purposes. Mr. Bell's account gives a vivid idea of the menace which these rodents are to the food supplies of North America, and the valuable results obtained by organised effort on a comprehensive scale for their control and eradication. The menace is equally serious in this country, and the measures adopted in America deserve the serious consideration of the Government and local authorities here.

WE have received an interesting letter from Mr. J. Anderson, of Sewerby, near Bridlington, stating that one of a fine group of the Chilean tree, *Araucaria imbricata*, at Sewerby House had produced a large number of seeds from which healthy young plants have been raised; he asks if this is an unusual occurrence. Mr. W. J. Bean, Royal Botanic Gardens, Kew, informs us that this is not a rare occurrence, and for many years past trees in various parts of the country have borne fertile seeds. He remembers so long ago as 1906 seeing self-sown young plants at Castle Kennedy, in Wigtownshire, growing beneath the trees from which the seeds had fallen. Similar self-sown seedlings may be seen at Strathfieldsaye, the seat of the Duke of Wellington; and other places where fertile seeds have been developed are Beauport, Tortworth, Castlehill, in North Devon, and Bicton, in South Devon. Mr. Anderson also states that some twenty-five or thirty years ago one of the trees "bled to death" from a scar caused by the breaking away of a branch. This also has been known to happen before. A case is known where a tree died from a running wound made at its base by the scythe of a workman mowing the grass. Mr. Anderson, however, records an interesting fact that we do not remember to have seen noted before: when the roots of the dead tree were being removed the workmen dug up large quantities of resin which had set into hard, amber-like masses. The seeds are eaten by the Araucanos and other Indian tribes in Chile. Mr. H. J. Elwes, who visited the native forests of this tree in 1901–2, states that he has eaten them both roasted and boiled and found them very palatable, with a nutty flavour somewhat like that of almonds.

DEVELOPMENT of the petroleum resources in Alaska has been, as we might have expected from the nature of the country, an extremely slow and somewhat costly matter; the comparative inaccessibility of the oil-bearing territory and the rigorous climatic conditions have combined to retard progress to the point of questioning the justification of a continuance of operations. The first well was brought in at Katalla in 1901, and was followed by a short-lived oil boom, afterwards depressed by the wonderful results of Californian development; since that year forty wells have been drilled in Alaska, thirty-one in the Katalla field and the remainder in other prospects, including the Iniskin Bay and Cold Bay districts; Yakataga, on the Pacific seaboard, and Smith Bay, on the Arctic coast, are mentioned as further areas where indications are good. The total production to date amounts to some 56,000 barrels of crude oil which has been refined and used locally; the oil is of paraffin base, of specific gravity varying from 41° to 45° (Baumé), high in petrol, and with no sulphur content; it is obtained from Tertiary beds the structure of which is at present doubtful. Geological exploration is a matter of great difficulty, and the results set forth in the preliminary report on the country (U.S. Geol.

Surv., Bull. 719) can only be regarded as tentative. It is doubtful whether Alaska will ever take rank as an important producing country, but oil will probably be obtained in sufficient quantity to meet local requirements.

SOUTHPORT CORPORATION has issued its annual report of meteorological observations for the year 1920, the results and discussions being carried out by Mr. Joseph Baxendell, meteorologist to the corporation. The report is circulated by the Air Ministry through the Meteorological Office and by the Corporation of Southport, as was done with the results for the year 1919. For many years these reports have stood out as specimens to show what can be done by corporations in England when there is a desire to aid in the advance of meteorology. The observations for 1920 are admirably treated, but there is rather less discussion of the observations than in some recent years, possibly due to the real lack of sufficient scientific assistants; it is stated in the report that a research computer is greatly needed. Research is going on to establish the trustworthiness of a five-year periodicity for wind direction, temperature, and rain in north-west England, and observations are contributed to the Meteorological Office for the daily, weekly, and monthly weather reports. The mean temperature of the complete year was 49·2° F., or 1° above the forty-five years' average. The total duration of sunshine in 1920 was 1277 hours, or 279 hours less than a twenty years' local average, and the smallest annual value yet recorded at Southport. North-westerly winds were deficient throughout the year, the deficiency amounting to little less than double the largest previous annual deficiency from that direction. The dominant feature of the year was the exceptional prevalence of winds from the southern half of the compass. The total rainfall for the year was 34·08 in., which is 1·24 in. above the normal. Observations of diurnal variation of wind direction and velocity, air temperature, and sunshine are of especial interest; as are also the observations of atmospheric pollution.

WIND observations in various Finnish lightships taken between 1914 and 1920 (Ström- och Vindobservationer vid Fyrskeppen) have been published by Dr. G. Granqvist in *Havsforsknings Institutets*, Skrift No. 10, 1921. The observations are from fourteen lightships in the Gulfs of Bothnia and Finland and one in Lake Ladoga. Most of them ceased late in 1914 and throughout the years 1915 to 1918, but the series is fairly complete in 1919 and 1920. The data, which were taken three times daily, are given in detail.

SEVERAL useful pamphlets on map projections have been issued by the Department of Commerce of the United States Coast and Geodetic Survey. A study of map projection in general (Special Publication No. 60) treats in a few pages with numerous illustrations of the fundamental ideas underlying the subject. A larger work is "Elements of Map Projection," by C. H. Deetz and O. S. Adams (Special Publication No. 68), which deals both with the theoretical side of the subject and the practical details of the construction of some of the most important projections. It is copiously illustrated with maps and diagrams and supplied with tables for the construction of Mercator's projection. At the low price of 50 cents it should find ready acceptance in this country. The third pamphlet (No. 67) deals with latitude developments connected with geodesy and cartography, and includes tables for the Lambert equal-area meridional projection.

THE paper read by Sir Vincent Raven before the North-East Coast Institution of Engineers and Shipbuilders on December 16 last is noteworthy, as it makes out a strong case in favour of electric traction on railways. The author is the chief mechanical engineer to the North-Eastern Railway Co., which is about to electrify 250 miles of its main-line system. It is well known that the steam locomotive engine has only half the economy of the steam stationary engine of the same size owing to the great difference in the economy of the boilers in the two cases. The question to be considered, therefore, is whether the great economy that could be effected by generating power on a large scale in a fixed station would be counterbalanced by the unavoidable losses in transmission and the interest on the capital cost of the transmission lines. The author quotes data which prove that electric traction is in nearly every case the more economical. As the North-Eastern Railway Co. intend to purchase their electricity from the supply companies operating in the district, a probable result will be the reduction in the price of electricity to ordinary consumers. This happened in 1904 when the Tyneside passenger lines were electrified.

IN a recent catalogue of the Snook apparatus by Messrs. Newton and Wright, Ltd., we find useful descriptions of two models of this well-known and trustworthy transformer; the Standard model is intended for radiographic work only, the Universal for all purposes, including deep therapy. This latter model is insulated with oil, and is also suitable for X-ray tests upon metals and for the many industrial purposes for which X-rays are being used. A brief description of a new time switch is given; this is based entirely on mechanical principles, and should form a useful addition to a radiographic outfit, for it has a working range of automatic action from 8 seconds to 1/30th of a second.

MESSRS. J. WOOLLEY, SONS AND CO., LTD., of 76 Deansgate, Manchester, have issued their annual pocket-book, "The Scientist's Reference Book and Diary for 1922," price 3*s*. 6*d*. In addition to the usual information given in diaries, there are brief particulars of the more important scientific societies and departments and numerous tables of physical and chemical constants which make the little volume extremely useful to teachers of science and other scientific workers.

DR. A. S. RUSSELL has written, for publication by Mr. John Murray, "The Chemistry of the Radio-elements." The work is intended to describe in a simple and concise form the main facts concerning

the chemical properties of the radio-elements and the bearing of this knowledge upon inorganic chemistry and theories of the structure of the atom. Among the topics dealt with are the relation of the radio-elements to the periodic system of classification, the properties of isotopes, the separation and purification of individual elements, and the analytical chemistry of uranium, thorium, and radium.

THE spring announcements of the Cambridge University Press contain several items of scientific interest, among which is the first volume, bearing the sub-title Foundations, of a forthcoming book by Prof. H. F. Baker entitled "Principles of Geometry." We learn from the preface that the work seeks to introduce the reader to those parts of geometry which precede the theory of higher plane curves and of irrational surfaces. Vol. 1 is devoted to the indispensable logical preliminaries. It assumes only those relations of position for points, lines, and planes which, furnished with a pencil, a ruler, some rods, and some string, a student may learn by drawing diagrams and making models. It seeks to set these relations in an ordered framework of deduction, gradually rendered comprehensive and precise enough to include all the later theory; to this end it puts aside, at first, most of those intricate details which make up the burden of what is generally called elementary geometry. Later volumes will deal, on the basis of the results obtained in this volume, with conics (and circles), with quadric surfaces and cubic curves in space, and with cubic surfaces and certain quartic surfaces.

Our Astronomical Column.

THE ORIGIN OF BINARY STARS.—Dr. J. H. Jeans discusses this question in the January issue of *Scientia*. He notes that binaries are of such frequent occurrence (practically half the stars) that we cannot regard them as freaks or abnormalities, but must seek for some explanation of very wide applicability. He considers three possible origins: (1) through fission of a single mass; (2) formation of adjacent nuclei in the original nebula, sufficiently close to each other to be held together gravitationally; and (3) capture, arising from the appulse of two stars originally independent. The last could lead to capture only if a resisting medium were present; moreover, there would be far too few close appulses to explain any appreciable fraction of the existing binaries. Dr. Jeans estimates that in a universe of a thousand million stars there would be ten thousand captures in a thousand million years. The first suggestion is shown to be possible only when a certain density of the rotating star has been attained (probably about that of the stars of B type). It is shown that this explanation accords well with the observed phenomena in the case of spectroscopic binaries, notably the low eccentricity of their orbits. Russell and others, however, have shown that the latus rectum of the orbit cannot increase very greatly, save under the action of considerable external forces, which are certainly not present now, and could only have been present in the past if the interstellar distances were then much smaller.

A test of the fission theory is afforded by triple systems, which generally consist of a close pair with a distant companion. Prof. Russell showed that the density of the central star would be at least 380 times greater at the second fission than at the first, which leads to such an improbable figure as to throw very grave doubts on the fission theory in the case of the wide pairs. Hence the second suggestion is taken to be by far the most probable explanation of the latter pairs. It must, however, be considered to indicate the *how* rather than the *why*; for the question remains why there should be so marked a tendency for nebular condensations to occur in pairs.

Dr. Jeans notes that star groups with common motion, such as the Taurus and Ursa Major clusters, can be most readily explained as arising from adjacent condensations in a primitive nebula; in these cases, however, the mutual distances were so great that the stars were outside each other's field of gravitational control.

THE ORBIT OF CASTOR.—Dr. W. Doberck gives in the centenary number of *Astron. Nachr.* an explanation of Villarceau's method of computing double-star orbits, which is analogous to Laplace's method for planetary orbits. He illustrates it by revising the orbit of Castor from the following four positions: 1719·84, 357·0° (4·82″); 1832·0, 259·0°, 4·61″; 1880·0, 234·5°, 5·63″; 1920·0, 216·0°, 5·03″. The first distance was not observed, but calculated. The author utilises his earlier orbit to shorten the approximations, and obtains the following orbit: ☊ 222° 7′, λ 67° 19′, γ 116° 6′, e 0·2875, P 477·5 years, T 1960·51, a 6·573″.

Predicted places, 1930·0, 210·4°, 4·58″; 1940·0, 203·0°, 3·98″. Owing to the approach to periastron the motion is accelerating It should be possible to obtain the relative masses of the components before very long; this is desirable as a check on the result suggested by the spectroscopic observations, which give the faint star six times the mass of the bright one.

SPECTRUM OF α CYGNI.—This spectrum is interesting from its relationship to the spectra of novæ. Its classification is A 2 (peculiar), and Dr. W. H. Wright has made a special study of the ultra-violet region, which is described in Lick Obs. Bull. No. 332. A spectrograph with two quartz prisms was attached to the Crossley reflector, and three photographs taken on June 11, 1921, two of them being on films which were bent to correspond with the curvature of the field. The limiting wave-lengths are 3245 to 4102, and 184 lines are recorded in the table, most of them being identified with known metallic lines, but they are unusually sharp and narrow compared with other A spectra. The hydrogen Balmer series is complete from Hδ to Hω. Dr. Wright states that the resemblance to the spectra of novæ is still more striking in the ultra-violet than in the visual region. A curve is given of the spectral intensity on the photographs: it falls very steeply between 3750 and 3650, then slowly and uniformly to 3245. The paper also contains some measurements of the red end of the α Cygni spectrum taken on stained plates. It is incidentally proved that some lines announced in this region by Dr. Waterman from photographs with a grating spectrograph really belonged to the blue region of the overlapping third-order spectrum.

Congress of Philosophy in Paris.

THIS congress, which was held in Paris on December 27–31 last, was organised by the Société française de Philosophie. It was not international in the same sense as the series of conferences interrupted by the war, but consisted of a special session of the French society, in which British, American, Italian, and Belgian societies were invited to take part by sending delegates. The British delegates were members of the Aristotelian Society, and included Prof. Wildon Carr, Miss H. D. Oakeley and Dr. Dorothy Wrinch, of the University of London, Prof. J. A. Smith, Mr. W. D. Ross, and Dr. F. C. S. Schiller, of the University of Oxford, Prof. W. R. Sorley, of the University of Cambridge, and Prof. Hoernlé, of the University of Durham.

The session was admirably organised under four sections. The first, devoted to logic and methodology, was presided over by M. Paul Painlevé; the second, devoted to metaphysics and psychology, by M. Henri Bergson; the third, which dealt with the history of philosophy, was under the presidency of Prof. Levy Bruhl; and the fourth section, dealing with social and moral philosophy, was organised by Prof. Bouglé. The mornings were occupied with sectional meetings; in addition, each section arranged one general afternoon meeting. Receptions in honour of the delegates were given by the president of the Société française and by the Rector of the Sorbonne, and the Société française de Philosophie also entertained all the members of the congress to dinner at the Club de la Renaissance.

Recent Developments of Relativity Theory.

In Section I. two subjects of scientific interest were discussed, viz. the theory of relativity and the theory of probability. The discussion of relativity, under the chairmanship of the president of the Société française de Philosophie, was opened by Dr. Dorothy Wrinch, who gave an account of the developments of the theory of relativity due to Weyl and Eddington. She explained how the electromagnetic-force tensor has been identified with a quite specific function of definite significance, in virtue of the fact that the electromagnetic force satisfies the usual Maxwellian equations, by means of an extension of the geometrical system dealt with by Einstein. Dr. Wrinch pointed out that the method of achieving this result was logically similar to the method used by Einstein in his identification of the energy tensor, covering energy, momentum, and stress in a field, with a certain function in his generalised geometry, and, indeed, the function used by Eddington in his further generalisations (Proc. Roy. Soc., 1921). Dr. Wrinch then referred to the existence of the new tensor discovered by Eddington (*ibid.*), and also to the fact that, although it is a development of the ordinary $^*G_{\mu\nu}$ tensor (in the sense that the $^*G_{\mu\nu}$ tensor is an abbreviated summary of it), its physical significance is very uncertain at present. The important logical procedure adopted by Eddington in the introduction of the axiom of the comparability of proximate relations was then made clear.

Prof. Langevin, who followed, gave an account of the development of the theory of relativity from its origin in the experiment of Michelson and Morley to its ramifications at the present day. He laid particular stress on the parallelism which has occurred in the development of geometry and physics, and he contrasted at some length the very different characteristics of these two parts of the theory of relativity. Prof. Langevin then gave an account of the curious manner in which non-Euclidean geometry has been developed from the Euclidean geometry of the last century, and he described the successive generalisations due to Weyl and Eddington. In the course of his exposition of Eddington's results Prof. Langevin then pointed out the manner in which geometry seems now to have gone ahead of physics, in that the geometrical function referred to above has not as yet been identified with any physical idea.

M. Paul Painlevé, who was the next speaker, brought forward certain objections to the theory of relativity which he had already indicated in two communications to the Paris Academy of Sciences in October and November last. He discussed in particular the admissible forms of the interval length ds, and pointed out the fact that various generalised functions $f(r)$ might be substituted for r in the coefficients of the squared differentials in the usual formula for the square of this interval length. All these forms indifferently satisfy the conditions, giving (*e.g.*) the same resulting motion of the perihelion of Mercury, but differing, on the other hand, in regard to the effect of solar gravitation on light traversing the sun's field. M. Painlevé laid great stress on this multiplicity of possible forms, and criticised the theory of Einstein on the ground of the multiplicity of possible forms in this particular formula and in other formulæ introduced at later stages.

A further objection was brought against the theory on the ground that no dynamical system can be constructed unless a privileged set of axes exists. Prof. Langevin, afterwards dealing with this point and with some of the paradoxes arising from it, and also from certain other postulates, pointed out that all theories allow the existence of a privileged set of axes in the neighbourhood of each point, but that no one set is necessarily applicable to the whole universe. A spirited discussion between the above-mentioned speakers followed, which dealt chiefly with certain of the more striking paradoxes to which the theory appears inevitably to lead.

The Theory of Probability.

Another meeting of Section I. of the congress—on this occasion a purely sectional meeting—discussed the modern developments of the theory of probability. The chair was taken by M. Hadamard, in the regretted absence of M. Emil Borel on account of illness. In his paper on "Les Axiomes du Calcul des Probabilités," M. Paul Lévy made public some important results which he has recently obtained by the application of the analytical ideas used by Lebesgue in his work on the theory of functions to F(x), the function representing the probability of an event x. The starting point of his theory is the fact that this function F(x) is necessarily a monotonic increasing bounded function of x. M. Lévy introduces $\phi(z)$, a *fonction caractéristique* of the probability, by refining it in terms of a Stieltje's integral,

$$\phi(z)=\int_{-\infty}^{+\infty} e^{izx}d\mathrm{F}(x).$$

This function he finds to be sufficient to determine F(x), and to be of fundamental importance in the later development of the leading ideas in a strict mathematical form. The paper raised many new points of

remarkable interest. For example, it pointed out the possibility of applying many of the most far-reaching results obtained by the modern school of analysts to this function $F(x)$ by means of a careful consideration of the assumptions which can plausibly be made concerning the characteristic properties of this function $F(x)$.

In the discussion which followed the reading of this paper, the "frequency" view of probability, according to which the probability of an event is a property definable in mathematical terms, was supported by M. Carvallo; but the contradictory view, which is, of course, the view of the majority of recent writers on the subject in England, was maintained in interesting speeches from M. Hadamard, Prof. Langevin, and others.

Geographical Outlooks.

THE Geographical Association held its annual meeting at Birkbeck College, London, on January 5 and 6. Lord Robert Cecil, as president, spoke on "Geography and Peace." If the Washington Conference was more efficient for peace than the League of Nations Council, this was partly because the latter had serious geographic constitutional defects, such as the absence of German, Russian, and United States representatives. Self-determination was easy to enunciate but most difficult to apply, because geographic conditions had resulted in extraordinary intermingling of peoples who, with inexplicable perversity, declined to live in watertight compartments. Racial and linguistic complexity is not, however, an impassable barrier to governmental unity, as Switzerland, with its three component peoples differing in history, language, and religion, indubitably proves. The Silesian decision was full of geographic interest. For purposes of tariffs, passports, and transportation the political boundary is ignored, and this may be a first experiment towards serious future modification of our State system.

Mrs. Ormsby (London School of Economics) from long-continued researches gave a demonstration lecture showing remarkable connections between original contours and drainage of London and Westminster and their present configuration. Her detailed contour maps are of great scientific interest, and should be published. Sir Halford Mackinder suggested that London originated as the port of St. Albans. Mr. R. L. Thompson (Rugby School), pleading for the better teaching of both history and geography, emphasised the need for superseding the narrowness of the personal and local points of view. We should envisage the weaving of the pattern of life linked through the ages by history and through space by geography. Sir Halford Mackinder spoke on problems of the Pacific. He asked for geographic imagination of the Pacific as a unity instead of the too prevalent view of it as a distant fringe of the European peoples. The Washington Conference had not laid down the limits of the Pacific, and this might be a serious omission, since such populous and prosperous islands as Java lie in the doubtful zone. The Pacific coastal fringes must become incalculably important because of their coal, mineral, and agricultural possibilities.

Dr. Fleure, hon. secretary of the association, lecturing to a joint meeting of historians and geographers, urged that subject-barriers in education should be diminished and that historians and geographers should co-operate to attain broader truth about human evolution. The long, bitter Russian winter so lowers human efficiency that continuously efficient popular criticism of government is impossible, and traditional routine is therefore important. In France the Roman South and the Paris basin differ historically in language, law, architecture, and economics. The boundary between them is a zone, not a line. Our political system needs re-adjustment by recognition of the zonal characters of frontiers. The maps of cities are full of clues for interpreting their life, and, when compared, illustrate remarkably the medieval spread of civic development from the Paris basin along the European plain. Mapping of prehistoric facts is another geographic study which will help to trace back the lineage of human institutions beyond the age of documents.

Miss L. Winchester (Liverpool University) discussed climatic variations in Palestine and factors of the serious summer drought which make storage for water from the winter rains an outstanding problem.

Dr. Hogarth lectured, with many original slides, on Hejaz as a central section of the age-long trade route between Syria and Yemen, with Mecca and Medina as stations on either side of an immense and high bluff of barren volcanic rock. The growth of Muhammadan life and pilgrimage on this basis was implicitly suggested, and its influence on the country was worked out to the practical conclusion that Hejaz could scarcely become a commanding political unit.

The outstanding features of the annual business meeting were the remarkable enthusiasm for geography shown by the fact that eleven hundred new members had joined the association during 1921, and the resolution sent to the Board of Education urging that, while fully recognising the enormous service which the system of advanced courses had rendered in raising the standard of secondary education, the Geographical Association felt that changed conditions emphasise the need for much greater freedom of teaching and grouping of subjects.

The Bow in Homeric Times.

THE Huxley memorial lecture of the Royal Anthropological Institute was delivered on November 29 by Mr. Henry Balfour, the title of the lecture being "The Archer's Bow in the Homeric Poems."

Mr. Balfour said that the principal passages in the Homeric texts relating to the archer's bow were: (1) the description of the bow of Pandarus (*Iliad*, IV.); (2) the account of the bow of Odysseus (*Odyssey*, XXI.). Both these bows were described merely as made of horn, but it was impossible to believe that *horn alone* was used in making so powerful a bow as that of Odysseus The bow of the Lycian Pandarus was made, according to the poet, from the horns of a single wild goat, but, on zoological grounds, this description could be shown to be inadequate, as such horns, if unaided, would not furnish material for making a practicable bow. It was suggested that either the horns of the Armenian wild sheep, or,

more probably, those of the water-buffalo, were used for both the bows referred to, and that even these would have required to be reinforced with a powerful "backing" of sinews to render them strong and efficient. Zoological, archæological, and ethnological evidence was adduced to show that in all probability the Homeric bows were true composite bows, built up with staves of wood and horn, and "backed" with sinews, after the fashion prevailing among the more skilled Asiatic bow-makers of later times. A study of Asiatic and Turkish composite bows showed that in all cases the sinew "backing" was protected by a sheathing of thin bark or leather, which concealed this part of the structure; while in many instances the horn forming the "ventral" surface was left uncovered and exposed to view. This fact may account for horn alone being referred to by Homer, since only this element in the structure was visible.

The following facts supported the theory of composite, sinew-backed construction:—

(1) The bows referred to in Greek texts are very frequently described as *reflexed* (παλίντονα) in the *unstrung* state. This is a special feature of composite bows.

(2) The extreme curvature imposed upon the bow of Pandarus when fully drawn (κυκλοτερὲς τόξον ἔτεινεν).

(3) The use of bow-cases (γωρυτοί) to protect the bows when not in use.

(4) The shape of many ancient bows as rendered in paintings or sculptures.

(5) The manner in which bows the shape of which suggests a composite construction were strung, and the fact (*Odyssey*, XXI.) that considerable knack as well as strength was required for this operation.

(6) Many bows represented in ancient Greek art exhibit asymmetrical curves, corresponding with Strabo's description of Scythian bows.

It seemed probable that the ancient Greeks derived a knowledge of the Asiatic composite bows from the Scythians, either directly through Thrace, or indirectly through Persia and Asia Minor, and the statement made by Pliny, "Arcum et sagittam Scythen Jovis filium, alii sagittas Persen Persei filium invenisse dicunt," may, probably, be taken as reflecting the actual derivation of the Greek composite bow from the Scythians or the Persians.

At the conclusion of the lecture the Huxley memorial medal of the institute was presented to Mr. Balfour by the president, Dr. W. H. R. Rivers.

University and Educational Intelligence.

CAMBRIDGE.—Dr. Haddon, Christ's College, has been appointed acting curator of the Museum of Archæology and Ethnology.

H. F. Holden, St. John's College, has been reelected to the Benn W. Levy studentship in biochemistry.

The Committee for Geodesy and Geodynamics has reported in favour of the erection and equipment of a two-roomed observation building near the Observatory as a first step towards the institution that the committee ultimately aims at to meet the requirements of international geodesy. Further, it is hoped to make provision for study and research in geodesy (including arc measurement, primary triangulation, precise levelling, and gravity determinations), geodynamics, and tidal phenomena. An appeal is to be made for assistance from private benefactions as soon as conditions are favourable.

The Alan Bodey prize of the annual value of 10*l.*, for an essay in applied mathematics, has been founded at Gonville and Caius College.

THE LORD MAYOR OF LONDON tenders his thanks to all who responded to his recent appeal for English books for Latvia. The announcement of the shipment to Riga of several thousands of books (forming the first instalment of the New Year gift of 50,000 volumes which the Lord Mayor hopes, with the further help of the public, to get together) has been received with the liveliest satisfaction in the newly founded Baltic State which has decided to adopt English as its second language and is anxious to assimilate English ideals, particularly in education. Further contributions of English books are solicited. Parcels should be addressed (carriage paid if possible) to Sir Alfred T. Davies, c/o the Consul-General for Latvia, 329 High Holborn, London, W.C.1.

A PROGRAMME of University Extension Lectures for the coming term has been issued by the University of London. Courses of lectures will be delivered at some seventy local centres in different parts of London and its suburbs, and a wide range of subjects is being offered. A few of the courses are of interest to readers of NATURE. Dr. W. B. Brierley is giving a course of twelve weekly lectures on "Some Problems in Modern Biology," which commenced on January 9 at Gresham College, Basinghall Street, E.C., and six lectures on "Inter-racial Problems of Man" at the Central Library, Fulham, commencing on February 7; Mr. J. Lionel Tayler is delivering a course of thirteen lectures at the Morley College, Waterloo Road, S.E., on "Heredity: The Scientific Drama of Personal and Social History," which commenced on January 4; and Prof. F. E. Fritch a course of ten lectures on "Nature Study (Plant Life) in the London Area" at the Central Library, Walthamstow, starting on January 26. Further particulars about the dates and times of the courses available and the fees charged can be obtained from the Registrar of the University Extension Board, University of London, South Kensington, S.W.7.

THE results of an interesting inquiry undertaken by Dr. J. Brownlee, director of the statistical department of the Medical Research Council, are published in the *Times* of January 16. Dr. Brownlee has taken the figures of the census of the British Isles of 1911 and has estimated from them the number of persons of any given age less than twenty-five years at present living in the British Isles and the numbers which may be expected in coming years if the conditions of hygiene represented by the 1910–12 life-table prevail. Taking the age for compulsory education, 5–6 years, the estimated number of children of that age in 1921 is 682,000; in 1922 it is 645,000; in 1923, 568,000; in 1924, 573,000; in 1925, 642,000; and in 1926, 772,000. Put into words, the estimates mean that there will be a decrease in the numbers of children of this age until 1923 and afterwards a rapid increase. Taking the next group, children of 7–12 years of age, the numbers living in 1921 are estimated as 2 per cent. less than those living in 1911, while the estimated population for 1921 between the ages of 12 and 20 years is about 7 per cent. in excess of that of 1911. In no case has account been taken of the effects of the war, emigration, etc., on that part of the population falling within the above groups, but it is considered that no error greater than 1 per cent. is introduced on this account. It will be interesting when the details of the 1921 census of Great Britain are published to see to what extent they are in accord with Dr. Brownlee's figures.

Calendar of Industrial Pioneers.

January 19, 1891. Robert Forester Mushet died.—The son of the discoverer of the black-band ironstone, Mushet made experiments on spiegeleisen—iron and manganese—which proved of great value in the development of the Bessemer process of steel-making. He also investigated alloys of iron with titanium, tungsten, and chromium, and about 1870 introduced the first of the self-hardening steels.

January 20, 1901. Zenobe Théophile Gramme died.—A Belgian carpenter, Gramme went to Paris, where at one time he worked under Ruhmkorff. His fame as an electrician is due to his re-invention in 1870 of the ring-armature dynamo first devised by Pacinotti. A monument to him stands in the Conservatoire des Arts et Métiers in Paris.

January 21, 1901. Elisha Gray died.—A distinguished maker of electrical appliances, Gray took out upwards of sixty patents, and was connected with the Western Electrical Co. of Chicago. On February 14, 1876, he applied for a patent for a telephone only a few hours after Bell had deposited his specification.

January 22, 1831. John Blenkinsop died.—One of the pioneers of the locomotive, Blenkinsop was an agent to some collieries. He took out a patent in 1811, and in 1812 at Leeds constructed an engine with a pinion gearing into a fixed rack. One of his engines was seen by George Stephenson.

January 22, 1887. Sir Joseph Whitworth died.—Among the greatest mechanical engineers of the nineteenth century, Whitworth worked with Maudslay, Holtzapffel, and Clement, and in 1833 set up as a tool-maker at Manchester. He improved machine-tools, perfected measuring machines, introduced standard gauges, and in the 'fifties brought out his valuable system of screw-threads. He also made experiments in artillery and developed the process of compressing melted steel under hydraulic pressure. The Whitworth scholarships and exhibitions were founded by him in 1869.

January 22, 1918. Sir John Wolfe Wolfe-Barry died.—An acknowledged leader in the world of civil engineering, Wolfe-Barry was prominently associated with the transport problems of London. Among his notable works was the Tower Bridge, completed in 1894. He was president of the Institution of Civil Engineers in 1897, and he initiated the Engineering Standards Committees.

January 23, 1805. Claude Chappe died.—The inventor of the semaphore signalling apparatus, Chappe was born in 1763. The statue of him in the Boulevard Saint-Germain in Paris depicts him explaining his invention to the Legislative Assembly in 1792. One of the first messages by semaphore was sent from the roof of the Louvre.

January 23, 1896. Ferdinand Schichau died.—A native of Elbing, where he opened a small shop in 1837, Schichau built Germany's first steam dredger, engined some of the earliest German steam men-of-war, and became a famous constructor of locomotives and torpedo craft.

January 25, 1917. George Andrew Hobson died.—As partner with the late Sir Douglas Fox, Hobson was responsible for many pioneering construction works in America and South Africa, his most remarkable work being the railway bridge over the Zambezi River at the Victoria Falls, the central span of which is 500 ft. long with a rise of 90 ft. He also worked out the plans for generating electricity at the Victoria Falls for the gold-mines of the Rand. E. C. S.

Societies and Academies.

LONDON.

Royal Society, December 8, 1921.—Sir C. S. Sherrington, president, in the chair.—Lord **Rayleigh**: A study of the glow of phosphorus: Periodic luminosity and action of inhibiting substances. The intermittent or periodic luminosity observed when the last traces of oxygen are being removed from air by means of phosphorus, or when air is allowed slowly to leak into an exhausted vessel containing phosphorus, requires the presence of water-vapour. Moderate drying (*e.g.* by sulphuric acid) makes the glow perfectly steady. Water-vapour has therefore the power of inhibiting the combination of phosphorus-vapour and oxygen within certain limits. When the composition of the mixture becomes favourable beyond those limits, a wave of combustion is propagated. Other substances are known to inhibit the glow of phosphorus, and exhibit the above phenomena in a more striking form than water. Camphor, ammonia, and pear-oil are among the most effective. The propagation of these waves of combustion cannot be attributed to the rise of temperature of one layer igniting the next layer, for the rise of temperature is too small. An alternative theory of the propagation is proposed, which assumes that it depends on the provision of nuclei, as in the propagation of crystallisation through a super-cooled liquid. On this basis a theory of the action of the inhibitors or "negative catalysts" is developed.—Lord **Rayleigh**: The aurora line in the spectrum of the night sky. The spectrum of the night sky at Terling (near London) has been photographed systematically. The aurora line at wave-length 5578 Å.U. is recorded on about two nights out of three. Its intensity on ordinary nights is not obviously related either to the amount of magnetic disturbance or to the transit of spots over the sun's central meridian. The intensity in the neighbourhood of Newcastle is notably less than near London, thus the effect appears to increase towards the south. It appears, therefore, to be due to some different cause from the Polar aurora. The aurora line does not coincide with krypton, and experiments to determine its origin gave negative results.—E. F. **Armstrong** and T. P. **Hilditch**: A study of catalytic actions at solid surfaces. VII.: The influence of pressure on the rate of hydrogenation of liquids in presence of nickel. The comparative rates of absorption of hydrogen at different pressures by a variety of unsaturated compounds in presence of nickel have been studied; the relation between the hydrogen pressure and the rate of hydrogenation is dependent on the type of organic compound examined. Simple ethylenic compounds are hydrogenated at rates almost proportional to the absolute pressure of the hydrogen. At very low concentrations of catalyst the increase in rate of hydrogenation becomes less than proportional to the increase in pressure. If the unsaturated compound contains another group which has affinity towards nickel, but is not open to hydrogenation, increase in hydrogen pressure causes an increase in the rate of hydrogen absorption. These results are in harmony with the authors' theory that catalytic hydrogenation is primarily conditioned by an association of the ethylenic linkage with the catalyst, the latter being also associated with hydrogen.—W. D. **Womersley**: The energy in air, steam, and carbon dioxide from 100° C. to 2000° C. Hydrogen and carbon monoxide mixed with either air or oxygen were exploded in a Hopkinson recording calorimeter for explosions. Curves showing the energy in the various gases and

the mean volumetric heats from 100° C. to 2000° C. are given. The values are, where comparable, about $7\frac{1}{2}$ per cent. higher than those of Holborn and Henning. The difficulty in estimating the heat liberated in a closed-vessel explosion is due probably to a spontaneous time reaction between the combustible gas and oxygen when the two are mixed, in which about 10 per cent. of the gas is consumed. The combustion of carbon monoxide is considerably slower than that of hydrogen. This makes the estimation of the heat liberated in the carbon monoxide experiments very uncertain.—J. W. **Gifford**: Atmospheric pressure and refractive indices, with a corresponding table of indices of optical glass. The modulus of rigidity for glass precludes its being sensibly affected by pressure, and therefore any pressure effect must be due to air alone. Two measurements of refractive index of the same wave-length, at different temperatures, are made, and by means of a new formula the refraction temperature-coefficient at standard pressure for 1° C. is determined. Using this as a final correction, indices for other wave-lengths at standard pressure and observed temperature may be brought to standard pressure and temperature (15° C.).—H. P. **Waran**: A new form of interferometer. A thin layer of transparent liquid floating over mercury is employed as a parallel plate interferometer—a substitute for Lummer and Ghercke's glass plate. Viscous castor-oil was successfully used, but its poor transparency stood in the way of securing high resolving power. The disturbing influence of the tremors of the ground was overcome by mounting the trough on a float suspended from the ceiling in a tank of water carried on a massive brick pillar with deep-laid foundations.—H. **Harle**: The viscosities of the hydrogen halides. An experimental determination of the coefficients of viscosity of the gaseous hydrogen halides was undertaken with the view of affording a check upon the theoretical investigation by A. O. Rankine on the diameters of unsymmetrical molecules. The method of continuous transpiration through a capillary tube was employed, using the known data for air. The gases were liquefied, and, by controlling the evaporation, established their own steady pressure while transpiring through the tube. The volumes of gas passing in a given time were found by absorbing in water and titrating with standard alkali solutions. Values of η were obtained at two temperatures, round about 15° C. and 100° C., and from them Sutherland's constant of temperature variation is calculated for each of the gases.

PARIS.

Academy of Sciences, January 3.—M. E. Bertin in the chair.—J. **Effront**: The distinctive properties of amylases of different origins. Specimens of amylase of different origins can be distinguished by the ratio between their liquefying power and sugar formed, by the optimum temperature when acted upon by diastase, and by their resistance to temperatures of 70°, 95°, and 100° C.—P. **Montel**: Quasi-normal families.—M. **Auric**: The generalisation of continued fractions.—MM. **Gossot** and **Liouville**: The principles of interior ballistics.—G. **Sagnac**: Newtonian invariants of matter and of radiant energy and the mechanical ether of variable waves.—H. **Chaumat**: The ballistic galvanometer.—R. **Jouaust**: The reception of waves maintained by modulation. In wireless telegraphy the detectors utilised at the receiving end give a very low yield. In the modification suggested the intensity of the current circulating normally in the receiving apparatus is modulated periodically with a given frequency. A current audible in a telephone is thus obtained the amplitude of which is half that circulating in the receiving apparatus. The method has been applied practically in transmission between Lyons and Paris, and proved to give increased sensibility.—M. **Taffin**: The annealing of glass. The formula given by Kundt in 1881 has been recently shown by Adams and Williamson not to apply rigorously to glass. The author has extended the experiments of Adams and Williamson, and proposes two modifications of their formula. The experimental results are compared with the three formulæ.—R. **Fosse** and A. **Hieulle**: The synthesis of hydrocyanic acid by oxidation, in ammonio-silver solution, of alcohols, phenols, and amines. In presence of ammonia and silver nitrate, hydrocyanic acid is one of the products of oxidation of various alcohols, phenols, and amines by permanganate. Quantitative figures are given for forty compounds, methylamine giving the highest proportion.—L. **Gentil**: The age of the phosphates of Morocco. A study of the fossils in the phosphate deposits of Morocco leads to the conclusion that they are mainly Cretaceous.—P. **Viennot**: The abnormal contact of the north Pyrenean Flysch at the north of Saint-Jean-Pied-de-Port.—P. **Négris**: Atlantis and the quaternary regression. A summary of facts proving a lowering of the level of the Atlantic by the subsidence of the sea-floor, and a discussion of the bearing of these facts on the legends of the submerged continent Atlantis. The facts cited include the form of the submarine floor of the Hudson River, the markings on the Island of Siphnos (Greece) up to a level of 700 metres, and the levels of the wood *débris* deposited by the Gulf Stream on Iceland.—A. **Allemand-Martin**: The lignites of Cap-Bon (Tunis). These lignites are comprised between the levels containing *Turritella fimbriata, Cerithium lignitarum*, and that of *Ostrea crassissima*; they are nearer the Tortonian period than the Helvetian.—L. **Moret**: The presence of limestones containing Alveolina, probably of Auversian age, at the base of the Nummulitic of the Arâche plateau (Massif de Plati, Haute-Savoie).—J. **Savornin**: The watershed of the Oum er Rebia (Morocco) and the general hydrography of the Moroccan middle Atlas.—P. **Lesage**: Study of saline plants during the period in which anomalies are produced.—R. **Combes**: The detection of the pseudo-bases of anthocyanidines in plant tissues. The results obtained by Noack on the extraction of the pseudo-bases of anthocyanidines from plant tissues are shown to be untrustworthy; the colour reactions obtained were probably due to the presence of phlobatannins.—M. **Martin-Zédé**: The influence of orientation on the success of the transplantation of trees. In trees transplanted without reference to their original orientation the loss in the following winter was 50 per cent., but taking care that the sides of the trees facing north were transplanted with the same orientation the loss was reduced to about 7 per cent.—M. and Mme. A. **Chauchard**: The measurement of the excitability of a secretory nerve: tympanic chord and the sub-maxillary gland.—R. **Stumper**: The poison of ants, and in particular formic acid. A proof that no other volatile acid than formic acid is present in ant poison.—A. **Lécaillon**: The characters of a hybrid issuing from the union of *Cairina moschata* and *Chenalopes aegypticus*.—R. **Courrier**: The independence of the seminal gland and the secondary sexual characters in fishes. Experimental study.—R. **Hovasse**: The regulation of the number of chromosomes in the parthenogenetic embryos of the reddish-brown frog. Its mechanism.—L. **Léger** and E. **Hesse**: The coccidia of marsh birds. The genus Jarrina.—A. **Sartory** and L. **Moinson**: A case of bronchial moniliasis. The fungus *Monilia Pinoyi* was isolated from the sputum of a patient suspected of tuberculosis.—

MM. **Rousselot** and A. **Marie**: A peculiarity of audition as a sign of syphilis.—A. **Zimmern** and E. **Salles**: The spectrographic study of the colour change of barium platinocyanide in the Villard effect.

SYDNEY.

Linnean Society of New South Wales, November 30, 1921.—Mr. G. A. Waterhouse, president, in the chair.—R. **Veitch** and W. **Greenwood**: The food-plants or hosts of some Fijian insects. A guide to the economic entomology of the Fiji Islands. The nature of the attack, the economic status of the insect, and the name of its food-plant or host are indicated.—J. G. **Myers**: The Australian apple leafhopper (*Typhlocyba australis*, Frogg.). This species has been introduced into New Zealand, where it does considerable damage to the foliage of apple and hawthorn, signs of its attack being rusty spots and patches on both sides of young and old leaves.—Vera **Irwin-Smith**: Notes on nematodes of the genus Physaloptera, with special reference to those parasitic in reptiles. A list of the species parasitic in each group is followed by a review of those found in reptiles, with special reference to their distribution in Australia. All known reptilian hosts for the genus, with the species parasitic in each, are given.—A. R. **McCulloch**: Notes on, and descriptions of, Australian fishes (2). Most of the fishes discussed were hitherto imperfectly known.—M. B. **Welch**: The occurrence of oil ducts in certain Eucalypts and Angophoras. Ducts occur in the medulla of the stems and leaves of certain Eucalypts of the Corymbosæ class and of *Angophora lanceolata*. They contain oil similar to that in the leaf oil glands—though not directly connected therewith—and function as storage reservoirs. The ducts indicate a primitive character, and show a close phylogenetic affinity between the Eucalypts and Angophoras.

Official Publications Received.

The National Union of Scientific Workers. Annual Report for Year ending 30th September, 1921. Pp. 36. (London: 25 Victoria Street.)

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, No. 10, 1921. Pp. 353-416. 1s. 4*d*. net. Bulletin of Miscellaneous Information: Appendix I-1922. Pp. 28. 8*d*. net. (London: H.M. Stationery Office.)

Memoirs of the Geological Survey of India. Vol. 40, Part 3: Petroleum in the Punjab and North-West Frontier Province. By Dr. E. H. Pascoe. Pp. x+330-494+xxii+plates 70-88. (Calcutta: Geological Survey; London: Indian Trade Commissioner.) 5 rupees.

Department of Agriculture, Punjab. Veterinary Bulletin, No. 2 of 1920: The Treatment of Surra in Camels by Intravenous Injections of Tartar Emetic. By Capt. H. E. Cross. Pp. iv+58. (Lahore: Government Printing Office.) 3 annas.

Department of Commerce. Scientific Papers of the Bureau of Standards. No. 423: Operation of the Modulation Tube in Radio Telephone Sets. By E. S. Purington. Pp. ii+377-406. (Washington: Government Printing Office.) 10 cents.

University of Illinois Bulletin. Vol. 18. No. 36. Bulletin No. 125, Engineering Experiment Station: The Distribution of the Forms of Sulphur in the Coal Bed. By H. F. Mancey and T. Fraser. Pp. 94. (Urbana: Engineering Experiment Station; London: Chapman and Hall, Ltd.)

Bulletin of the National Research Council. Vol. 2, Part 7, No. 15: A List of Seismologic Stations of the World. Compiled by H. O. Wood. Pp. 397-538. (Washington: National Research Council.) 2 dollars.

New Zealand. Department of Mines: Geological Survey Branch. Bulletin No. 23 (new series): Geology and Mineral Resources of Western Southland. By J. Park. Pp. vi+88+8 plates+2 maps. (Wellington, N.Z.) 5s.

Diary of Societies.

THURSDAY, JANUARY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—S. Gordon: Mountain Birds of Scotland.

ROYAL SOCIETY, at 4.30.—Prof. L. Hill, H. M. Vernon, and D. H. Ash: The Kata-Thermometer as a Measure of Ventilation.—Lt.-Col. C. B. Heald and Maj. W. S. Tucker: Recoil Curves as Shown by the Hot-wire Microphone.—E. W. A. Walker: The Occurrence and Development of Dys-agglutinable, Eu-agglutinable, and Hyper-agglutinable Forms of Certain Bacteria.—Marjory Stephenson and Margaret Whetham: Studies in the Fat Metabolism of the Timothy Grass Bacillus.—J. A. Gardner and F. W. Fox: The Origin and Destiny of Cholesterol in the Animal Organism. Part 12: The Excretion of Sterols in Man.—Dr. S. J. Lewis: The Ultra-violet Absorption Spectra and the Optical Rotation of the Proteins of the Blood Sera.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. E. Marion Delf: Studies in *Macrocystis pyrifera*, the Giant Alga of the Southern Temperate Zone.—J. L. C. Musters: The Flora of Jan Mayen Island.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—J. F. Allan: A Typical Example of Magmatic Injection.—W. E. Whitehead: Steep Sights in Underground Surveys.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Brig.-Gen. R. K. Bagnall-Wild: Aeroplane Installation.

INSTITUTION OF ELECTRICAL ENGINEERS (Joint Meeting with Institution of Heating and Ventilating Engineers), at 6.—Discussion: The Utilisation of Waste Heat from Electrical Generating Stations, with the following Introductory Papers: C. I. Haden: Utilisation of Exhaust Steam from Electric Generating Stations, and Coal Economy.—F. H. Whysall: The Utilisation of Waste Heat from Electrical Generating Stations.

CHEMICAL SOCIETY, at 8.—Prof. A. Smithells: Models of the Lewis-Langmuir Atom, with Explanations.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.1), at 8.15.—Dr. E. J. Butler: Some Relations between Vegetable and Human Pathology.

FRIDAY, JANUARY 20.

INSTITUTE OF TRANSPORT (at Royal Society of Arts) (Graduates' and Students' Lecture), at 5.—G. T. Hedge: The Operation of an Important Railway Goods Terminal.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion on Isostasy: Capt. Alessio, Col. Sir G. P. Lenox-Conyngham, Prof. Plumbach, and others. Col. H. G. Lyons in the chair.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Hunterian Lecture: The Mongolian Face and its Modifications.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—A. Tweedie: Short Account of the Research Work being conducted in Utrecht on the Saccular, Utricular, and Allied Reflexes (continued).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—H. S. Denny and N. V. S. Knibbs: Some Observations on a Producer-gas Power Plant.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—L. T. Hinton: Some Applications of the Thermionic Valve to Telephony.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—S. Hassledine: Classifications of the Pleistocene Age.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—Lecturette: Geology in its Relation to Engineering.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. Zimmern, Dr. Agnes Savill, Dr. Sloan-Chesser, Dr. C. A. Robinson, Dr. W. J. Turrell, and others: Discussion: Electro-therapy in Gynæcology.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir James Dewar: Soap Films and Molecular Forces.

SATURDAY, JANUARY 21.

BRITISH MYCOLOGICAL SOCIETY (in Botany Lecture Theatre, University College), at 11 a.m.—Dr. W. Brown: The Germination and Growth of Fungi at Various Temperatures and in Various Atmospheres.—Miss D. M. Cayley: Die Back of Stone Fruits due to Diaporthe Perniciosa and the Behaviour of Monospore Cultures in Artificial Media.—W. B. Crow: The Morphology and Affinities of Leuconostoc Mesenteroides.—Dr. H. Wormald: Notes on Crown-gall.—Dr. M. C. Rayner: Obligate Symbiosis in Calluna.—W. J. Dowson: Michaelmas Daisy Wilt.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. C. Macpherson: The Evolution of Organ Music (1).

MONDAY, JANUARY 23.

PHYSIOLOGICAL SOCIETY (at King's College).—Annual General Meeting.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—S. T. Klein: The Invisible is the Real, the Visible is only its Shadow.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Hunterian Lecture: The European Face and its Chief Variations in Type.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—R. J. Mitchell and others: Discussion: Electric Vehicles: Present and Future.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Meeting), at 7.—F. A. Best: Airships.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Prof. W. Rothenstein: Architectural Draughtsmanship.

ROYAL SOCIETY OF ARTS, at 8.—C. Ainsworth Mitchell: Inks (Cantor Lectures) (1).

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. F. J. Poynton and Dr. J. W. McNee: A Case resembling Leukœmia, but presenting unusual Clinical and Pathological Features.—T. H. Kellock: A Method of Treating Abscesses.—Dr. W. Broadbent: Observations on Heart Disease.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—C. J. Edmonds: Luristan.

TUESDAY, JANUARY 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. F. H. A. Marshall: Physiology as Applied to Agriculture (2).
NEWCOMEN SOCIETY (at Caxton Hall), at 5.—Dr. T. E. Jones: Mechanics of Engineering from the Time of Aristotle to that of Archimedes.
ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. C. Boulton, Sir Cuthbert Wallace, Dr. Ryffel, and Dr. A. E. Barclay: Discussion: The Diagnosis of Gastric Ulcer.
INSTITUTION OF CIVIL ENGINEERS, at 6.—A. W. Rendell: Control of Trains, in Relation to Increased Weight and Speed Combined with Reduced Headway.—Sir Henry Fowler and H. N. Gresley: Trials in Connection with the Application of the Vacuum-brake for Long Freight Trains.
WOMEN'S ENGINEERING SOCIETY (at 26 George Street, W.1), at 6.15. —Miss Gwynne Howell: Domestic Engineering.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—C. M. Thomas: The Plate and the Photographer.
INSTITUTE OF INDUSTRIAL ADMINISTRATION (at London School of Economics), at 8.—J. M. Fells: Industrial Economics in Relation to the Bearing on National Welfare of the Ascertainment of Cost, with discussion by Sir Lynden Macassey, Sir James Martin, and others.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Anniversary Meeting.

WEDNESDAY, JANUARY 25.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Hunterian Lecture: The Study of Certain Aberrant Types: Bushmen, Eskimo, Lapp, and Ainu.
INSTITUTE OF CHEMISTRY (London and South-Eastern Counties Section) (at 30 Russell Square, W.C.1), at 6.—Exhibition of Apparatus other than Glassware.
INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—E. W. Monkhouse: The Economic Aspects of Various Methods of Power-transmission.
ROYAL SOCIETY OF ARTS, at 8.—H. M. Edmunds: Photo-sculpture.
ROYAL SOCIETY OF MEDICINE, at 9.—Prof. G. Elliot Smith: The Rhodesian Skull.

THURSDAY, JANUARY 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—S. Gordon: Sea Birds and Seals.
ROYAL SOCIETY, at 4.30.—*Probable Papers*.—W. B. Hardy and Ida Doubleday: Boundary Lubrication: The Paraffin Series.—Prof. W. A. Bone, A. R. Pearson, E. Sinkinson, and W. E. Stockings: Researches on the Chemistry of Coal. Part 2: The Resinic Constituents and Coking Propensities of Coals.—Dr. J. A. Crowther and B. J. Schonland: The Scattering of β-rays.—Ann C. Davies: The Minimum Electron Energies associated with the Excitation of the Spectra of Helium.—C. N. Hinshelwood, H. Hartley, and B. Topley: The Influence of Temperature on Two Alternative Modes of Decomposition of Formic Acid.—Prof. C. V. Raman: The Molecular Scattering of Light in Water and the Colour of the Sea.
CONCRETE INSTITUTE, at 7.30.—E. B. Moullin: Capillary Canals in Concrete, and the Percolation of Water through Them.
ROYAL MICROSCOPICAL SOCIETY (Metallurgical Section), at 7.30.—H. Wrighton: Demonstration of Polishing Metal Specimens.
ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.

FRIDAY, JANUARY 27.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Prof. E. P. Stebbing and others: Discussion: The Importance of Scientific Research in Forestry and its Position in the Empire.
ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—A. L. Howard: The Timbers of India and Burma.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Hunterian Lecture: The Facial Characteristics of the Races native to India.
JUNIOR INSTITUTION OF ENGINEERS, at 8.—L. M. Jockel: Fuels and the Boiler-house.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Viscount Burnham: Journalism.

SATURDAY, JANUARY 28.

ESSEX FIELD CLUB (in Physical Lecture Theatre, West Ham Municipal College), at 3.—C. Nicholson: The Rosy-Marbled Moth (*Erastria venustula*) in Britain (with special reference to Essex). —G. Morris: Some Neolithic Sites in the Valley of the Essex Cam.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. C. Macpherson: The Evolution of Organ Music (2).

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

THURSDAY, JANUARY 19.

KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (1).
ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN, at 6.—Dr. W. Griffith: Diseases of the Skin Appendages (Chesterfield Lecture).

FRIDAY, JANUARY 20.

METEOROLOGICAL OFFICE, SOUTH KENSINGTON, at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (1).
MIDDLESEX HOSPITAL MEDICAL SCHOOL, at 3.—Sir James Kingston Fowler: Diagnosis (Emeritus Lecture).
KING'S COLLEGE, at 5.—Prof. R. Robinson: Orientation and Conjugation in Organic Chemistry from the Standpoint of the Theories of Partial Valency and of Latent Polarity of Atoms (1).
KING'S COLLEGE, at 5.30.—Rev. Dr. F. A. P. Aveling: Matter, Mind, and Man.

SATURDAY, JANUARY 21.

UNIVERSITY COLLEGE, at 10.30 a.m.—A. Chaston Chapman: Yeast: What it is, and what it does (Lecture for Teachers).
LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (1).

MONDAY, JANUARY 23.

KING'S COLLEGE, at 5.30.—Prof. C. L. Fortescue: Wireless Transmitting Valves (1).

TUESDAY, JANUARY 24.

KING'S COLLEGE, at 5.30.—F. H. Rolt: Accurate Measurements in Mechanical Engineering: The Use and Testing of Gauges (1).

WEDNESDAY, JANUARY 25.

HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (1).

THURSDAY, JANUARY 26.

UNIVERSITY COLLEGE, at 5.15.—B. S. Rowntree: Industrial Unrest.
KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (2).
ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN, at 6.—Dr. W. K. Sibley: Alopecia and its Treatment (Chesterfield Lecture).

FRIDAY, JANUARY 27.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (2).
TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at the Mary Ward Settlement, Tavistock Place), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (1).

SATURDAY, JANUARY 28.

LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (2).
HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: The Life and Habits of Mason Bees.

CONTENTS.

NATURE

THURSDAY, JANUARY 26, 1922.

Editorial and Publishing Offices:
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The Langley Aeroplane and the Hammondsport Trials.

THE Americans most intimately associated with the work of Prof. S. P. Langley have written to the Royal Aeronautical Society and to NATURE protesting vigorously against the conclusions reached by Mr. Griffith Brewer and summarised in a paper[1] read before the society in October last. The conclusions were[2] :—

(*a*) The Langley machine was not capable of sustained free flight.

(*b*) The Langley machine was not successfully flown at Hammondsport, New York, on June 2, 1914.

The correspondence is published in full in the Journal of the Royal Aeronautical Society, and when discussion is closed it is to be hoped that the society itself will consider the whole matter and express an official opinion. In the meantime it may be assumed that the American presentation of the case is better than that of Mr. Brewer when they claim that in all substantial respects the original Langley aeroplane was capable of sustained flight. It is true that certain modifications were made for the Hammondsport trials which changed the machine in some of its details, but the secretary of the Smithsonian Institution, Dr. Walcott, appears to put the matter very fairly when he says :—

> "I was present at Hammondsport on May 31, 1914, and saw the machine with the original engine giving only two-thirds the original thrust and with wings approximately of the original design, but far rougher executed, get under way from rest and fly gracefully, carrying, besides a man, more than 300 lb. of floats in excess of what the machine was designed to carry. I am still confident that what it did under these relatively adverse circumstances is far inferior to what it was capable of doing in its original condition."

[1] *Aeronautical Journal*, December, 1921.
[2] *Ibid.*, p. 629.

It is much to be regretted that anything happened to prevent a successful flight of the Langley flying machine on October 7, 1903, for no one with an intimate knowledge of the subject can doubt that, aerodynamically and structurally, the machine was good. Aerodynamically it had been preceded by a long series of experiments on a whirling arm, culminating in the flight of a power-driven model based on the results obtained. Although the practical man is loth to admit the fact, it is nevertheless true that the very great bulk of trustworthy information is derived from tests on models by men of science. For very many years to come aviation will continue to draw its inspiration from results obtained on models. Structurally the Langley aeroplane had been carefully made and tested by loading with sand; it is difficult to give credence to Mr. Brewer's suggestion that the structure was obviously defective. Nor is there lack of evidence in the other direction in the later flights. The account of the original failure, vouched for by Mr. C. M. Manly, the pilot on the occasion, is that :—

> "The machinery was working perfectly and giving every reason to anticipate a successful flight, when this accident (due wholly to the launching mechanism) drew the aeroplane abruptly downward at the moment of release and cast it into the water near the houseboat."

This explanation is supported by clear observations of damage to the clutch which held the aeroplane on the launching ways, but is apparently not accepted by Mr. Brewer.

Despite the failure to crown his efforts with a striking popular flight, Langley's work was a very great achievement and removed many difficulties from the paths of his successors, amongst whom were the Wright brothers.

The claims made for Langley by the Smithsonian Institution are :—

> (1) His aerodynamic experiments, some published and some as yet unpublished, were complete enough to form a basis for practical pioneer aviation.
>
> (2) He built and launched, in 1896, the first steam model aeroplane capable of prolonged free flight, and possessing good inherent stability.

(3) He built the first internal-combustion motor suitable for a practical man-carrying aeroplane.

(4) He developed and successfully launched the first gasoline model aeroplane capable of sustained free flight.

(5) He developed and built the first man-carrying aeroplane capable of sustained free flight.

Only the last of these items appears to be in dispute, and, even were adverse criticism justified, the merit of Langley's work would scarcely be affected. It is not disputed on the other side that the Wright brothers made the first sustained flight and so marked a stage of progress which appealed to the world at large instead of to a limited number of men of science. The list of earlier contributors to progress in aviation is long, and all deserve some credit for the ultimate result, but the modern phase took its beginning with the publication of Langley's researches on aerofoils, etc., and the additional spur given by the successful flights of his power-driven models.

It is not too much to say that more original and personal solid work underlay the Langley aeroplane than is the case for any other aeroplane, not excepting those of the present day. The solution of the problems of stability which Langley reached as a pioneer in one instance is still beyond the powers of the majority of his successors in the art of aeroplane design.

Intestinal Protozoa of Man

The Intestinal Protozoa of Man. By Clifford Dobell and F. W. O'Connor. Pp. xii + 211 + 8 plates. (London: Published for the Medical Research Council by J. Bale, Sons, and Danielsson, Ltd., 1921.) 15*s.* net.

THIS is a treatise which will be very valuable to the medical investigator of the microscopic intestinal parasites of man—other than those belonging to the great group of Bacteria. Its origin is due to the continuous and comprehensive study, made during the great war, of the relation to parasitic Protozoa of dysenteric disease occurring in the British Army. Mr. Clifford Dobell has previously published various reports of his masterly work on this subject, and two years ago (December 11, 1919, vol. 104, p. 369) we noticed in these columns his critical essay entitled "The Amœbæ Living in Man." In the present publication Mr. Dobell has been assisted by Mr. F. W. O'Connor, who had independently carried on investigations on intestinal Protozoa in connection with the Egyptian Expeditionary Force. Mr. O'Connor was to have been specially responsible for the medical parts of this book, and Mr. Dobell for those parts which are purely zoological. But, owing to the departure of his medical colleague in 1919 on an expedition to the Gilbert and Ellice Islands, the task of completion of the work and responsibility for the greater part of it have fallen on Mr. Dobell. The treatise is distinguished by that patient inquiry into previous work and critical judgment as to nomenclature and synonomy which have rendered Mr. Dobell's earlier publications of special value. It is absolutely necessary that medical men and protozoologists should agree upon a terminology in order that they may understand each other's writings, and this result Mr. Dobell's careful review and original observations enable them to achieve.

The book is divided into nine chapters, followed by a very complete bibliography and an index and eight plates. Chap. 1 is an introduction to the whole subject, and is followed by chap. 2 on the intestinal Amœbæ of man; chap. 3, Amœbiasis (the name given to infection by Amœbæ, and especially by *A. histolytica*); chap. 4, the intestinal Flagellates of man; chap. 5, the intestinal Coccidia of man; chap. 6, the intestinal Ciliates of man; chap. 7, the diagnosis of intestinal protozoal infections; chap. 8, the treatment of intestinal protozoal infections; and chap. 9, the coprozoic Protozoa of human fæces.

One of the chief sources of error which has to be guarded against by the novice in this study is that of supposing that parasites found in the fæces are necessarily parasites of the intestine. There is a whole series of Amœba-like and flagellate Protozoa which are present in the soil and may obtain access to, and develop in, the fæces after deposition. These are called "coprozoic Protozoa." They may also obtain access to the fæces by means of resistent spores which are swallowed with dust and pass uninjured and undeveloped into the intestinal contents. Apparently the high temperature of the intestine is unfavourable to their development, which occurs only when they have passed to the cooler conditions of the outer world. Many mistaken descriptions of protozoal parasites have been due to this source of error.

The Protozoa which are not merely coprozoic, but actually live in the intestine of man, are only seventeen in number—viz. five Amœbæ, five Flagellata, four Coccidia, and three Ciliata. Some of these are very rare or exceptional; others are abundant, but are not shown to be harmful. Only two which actually sometimes (but not always) destroy the tissue of the intestinal wall or of other organs when present in man are admitted by Mr. Dobell to be pathogenic—viz. *Entamoeba histolytica* and the ciliate *Balantidium coli.* The work of recent years, and much of that of Messrs. Dobell and O'Connor,

has led to this interesting result. The tendency among medical men was to regard every intrusive Entozoon in the human body as "a dangerous parasite," and now we know not only that parasitic Protozoa are not necessarily dangerous, but also that many parasitic bacteria and even some worms are not harmful to their hosts.

Mr. Dobell is inclined to modify the ancient and, as it seems to me, convenient use of the word "parasite." It is not usual to regard every parasite as "a dangerous parasite." One hears of a "harmless parasite" also, and of "mere parasites." In fact, the Greek word means "alongside the victuals," and signified in early times one who had a seat at the table of sacrificial meats—an officially established guest or messmate of the priests. He was "venerable" rather than dangerous, and only when rich men took to entertaining such pensioners for the purpose of display and self-advertisement did "the parasite" fall into contempt and was sneered at as a "toady." The use of the word in zoology has been primarily in accordance with this. The parasite of zoology infests or hangs on to a host from which it obtains shelter and food, but it does not necessarily injure its host. There are many gradations between the harmless necessary parasite and the deadly pest which converts a "host" into a "victim"—absorbing its life-blood or spreading deadly poison into its tissues.

It is difficult to create a terminology which shall in single words indicate the varieties of relationship of parasite and host. The word "commensal" was introduced by the elder Van Beneden. Etymologically it has the same meaning as parasite, but Van Beneden used it to signify specifically an association in which the host suffered no injury or inconvenience, but allowed a distinct species of animal or plant to benefit by the scraps of food rejected by itself, and even to get shelter and carriage by its hospitality. At the same time, Van Beneden pointed out that such close parasitism as that of the intestinal worms is not necessarily injurious to the animals infested, and he cited the fact that, whilst in their normal wild condition the larger carnivorous animals apparently without exception harbour parasitic worms and are perfectly healthy, it is found that the same animals in captivity tend to lose their parasites. They, in fact, become unhealthy and abnormal in captivity. The presence in these animals of a few parasites is (according to Van Beneden) normal and an indication of life in health-giving conditions. For such reasons I should prefer to retain the word "parasite" with its original wide and general meaning, and to classify by name (a somewhat troublesome task) the varieties which it presents.

E. RAY LANKESTER.

Electric Furnaces.

The Electric Furnace. By Dr. J. N. Pring. (Monographs on Industrial Chemistry.) Pp. xii + 485 + 19 plates. (London: Longmans, Green and Co., 1921.) 32*s.* net.

LITTLE more than 100 years have elapsed since the first experiments on electric furnaces were performed, when Davy, in 1810, succeeded in isolating aluminium and the alkali metals by the electrolysis of electrically fused salts. Five years later Pepys carried out experiments on the cementation of iron heated by passing an electric current through it. About half a century elapsed, however, before a commercial furnace was put into operation, one of the earliest being built by the Cowles brothers, at Milton, Staffs. The development that has taken place since that date may be gauged from the fact that the estimated production of electric furnace steel during 1918, in Great Britain alone, was 110,000 tons. This development was largely due to the war and, as the last edition of Stansfield's classic volume (bearing the same title as the book at present under review) is dated 1914, a demand doubtless exists for a further book on electric furnaces.

After dealing with the history and the principles of electric furnaces, the author discusses the types used in laboratory and experimental work. He claims that it is possible to maintain a temperature of 1200° C. inside a tube 8·6 cm. internal diameter, wound with No. 15 s.w.g. nichrome wire. The makers of this material state that it is suitable for use at temperatures up to 1100° C., and while there is no doubt that the higher temperature could be attained, the author was indeed fortunate if his furnace did not burn out in a short time.

The next two sections of the book deal with current supply and transformation in electric furnace operations. These subjects are discussed very fully, commencing with the theory of alternating currents. There is a mistake in the first figure in this section (Fig. 49), both collector brushes of the diagrammatic dynamo being shown on the one slip ring.

A later section, 6, discusses the measurement of high temperatures, dealing mainly with the use of optical and radiation pyrometers. A curious statement occurs on p. 84, where reference is made to thermo-couples consisting of "two different metals such as platinum and an alloy of platinum with rhodium or ruthenium." Surely iridium, not ruthenium, is intended.

The next three sections deal with the chemical,

in contradistinction to the metallurgical, manufactures carried out in the electric furnace, viz. the making of calcium carbide, the synthesis of nitrogen compounds from the atmosphere, and the ammonia oxidation process. In the section on the synthesis of nitrogen compounds it is stated that the world's production of calcium cyanamide during 1918 was estimated to be more than three-quarters of a million tons, of which nearly one-third of a million tons was made in Germany.

In sections 10 to 16 and section 18 an account is given of the use of the electric furnace for the production of metals, alloys, and refractories. The importance of these operations is shown by the fact that, in 1918, 100,000 tons of pig-iron were produced in Sweden in the electric furnace, while during the previous year one and a quarter million tons of electric steel ingots and castings were manufactured in the United States. The section dealing with the manufacture of aluminium is disappointingly short in view of the importance of this metal, about 100,000 tons of which are produced annually at the present time solely by means of the electric furnace.

Attention must be directed to a curious misstatement in this part of the book. It is said (p. 294) that in the electrical smelting of zinc there is a tendency to the formation of a grey powder "due to rapid cooling, whereby the metal passes direct from the vapour to the solid condition, the boiling-point of the metal being only slightly removed from the melting-point." Actually, the boiling-point of zinc, at atmospheric pressure, is more than 900° C., while its melting-point is 418° C. Further, the use of the word "matte" on p. 168 for the metallic product from an iron-making blast-furnace appears to be undesirable.

The remaining sections of the book deal with miscellaneous furnaces, electrolytic processes, and questions of design and power supply.

The book will doubtless be a very valuable addition to the library of the metallurgist and electrical engineer, and it is to be hoped that a second edition will be called for soon, partly to enable the numerous misprints to be corrected. To select a few at random: p. 37, "Electrical connection . . . are conveniently made"; p. 87, an x is evidently omitted from the formula; p. 290, the word "downward" appears to be displaced, presumably from the line above; p. 269, "a Belgian Compant . . ." should doubtless read "a Belgian Company . . ." Furthermore, if the author were to take to heart the dictum reiterated by Rickard in his invaluable book on "Technical Writing" and remember the reader, the demand for a second edition would give him an opportunity of rewriting some of his sentences, particularly the following: "Currents up to 6000 amps. can be lead up to the furnace walls, along two heavy bars for single phase, and three for two or three phase and connected by flexible cables to the electrodes." Or, "According to Prof. J. W. Richards, pig-iron was, in 1920, being produced in Sweden in electric furnaces from charcoal at a cost of 5 dollars per ton less than their own blast-furnace pig-iron."

J. L. H.

Chemistry after the War.

(1) *A Dictionary of Applied Chemistry.* By Sir Edward Thorpe. Assisted by eminent contributors. Vol. 1, *A–Calcium.* Revised and enlarged edition. Pp. x+752. (London: Longmans, Green, and Co., 1921.) 60*s.* net.

(2) *A Text-book of Electro-chemistry.* By Prof. Max le Blanc. Translated from the fourth enlarged German edition by Dr. Willis R. Whitney and Dr. John W. Brown. Pp. xiv+338. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1920.) 18*s.* net.

(3) *Thermodynamics and Chemistry.* By Prof. F. H. MacDougall. Pp. v+391. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 30*s.* net.

(1) IT was almost inevitable that, when the distractions caused by the war had diminished somewhat, there should be a call for a new edition of Thorpe's Dictionary. Whilst pure chemistry may have made comparatively little progress during the war, applied chemistry has received a very great stimulus during the period that has elapsed since the former edition appeared in 1912. The first volume of the new edition has expanded from 614 to 752 pages, or rather more than one-fifth, and whilst it is difficult, without a careful comparison with the old edition, to discover where the expansion has taken place, it is easy to see that the most striking developments are adequately described in the new volume, so far as they are covered by the section from "A" to "calcium." Thus under "acetic acid" and "aldehyde" the manufacture from acetylene is described; under "amatol" there is a forward reference to an article on explosives which will appear in a later volume, and a brief account is given of the new methods used

to prepare ammonium nitrate on a large scale. The synthetic processes for the production of ammonia are described very briefly in a single column, but this is in accord with the classification of the former edition, where a full description of these processes is reserved for a later article under "nitrogen." The revision, as a whole, has been well done, and the new edition can be commended heartily as an accurate presentation of the state of applied chemistry after the vicissitudes of recent years.

(2) The publishers of le Blanc's "Text-book of Electro-chemistry" have adopted a simpler method of meeting the demand for a new edition. Although the title-page is dated 1920, the translator's preface bears no date. No references later than 1907 have been discovered by the reviewer, and the table of equivalents is certainly more than ten years old. In view of the rapid growth of the science of electro-chemistry, further comment is scarcely necessary.

(3) Prof. MacDougall's book contains an attractive and lucid account of the principal applications of thermodynamics to chemistry. The author writes as a chemist rather than as a mathematician, and, instead of giving merely an occasional numerical illustration of his equations and formulæ, has provided quantitative data even when these are scarcely needed to elucidate the text. Thus it is a pleasure to find a full list of specific heats of the solid elements, a table of the heat-capacities of gases and of the ratio of their specific heats at different temperatures, as well as useful tables of the heats of formation of metallic and non-metallic compounds and of heats of solution, combustion, and neutralisation. In the same way the later chapters contain useful tables of electrode-potentials, equivalent conductances, ionisation-coefficients, transference numbers, and ionic conductances. In dealing with the phase rule, one chapter only is devoted to theoretical considerations, whilst three chapters are required to cover the various examples which the author has selected to illustrate the applications of the rule. Another valuable feature of the book is the insertion at the end of each chapter of a large number of problems. These are of a very practical character, and illustrate clearly the many ways in which a knowledge of thermodynamics may be made use of in the study of chemical problems. Certainly no book with which the reviewer is acquainted presents the subject in a manner more likely to prove attractive to the chemist.

T. M. L.

Prices and Wages.

Prices and Wages: An Investigation of the Dynamic Forces in Social Economics. By P. Wallis and A. Wallis. Pp. xii + 456. (London: P. S. King and Son, Ltd., 1921.) 25*s*. net.

THE authors of this volume are, it may be gathered from the preface, business men without much literary experience. The consequent defects of the book, it is to be feared, render it unlikely that many readers will be found with sufficient patience to attempt the whole. Four hundred and fifty pages of reasoning and criticism are at the best a heavy task; when the reasoning is often obscure and unnecessarily verbose, when the criticism seems often ill-informed or based on misunderstanding, the task is apt to become almost unendurable.

The argument appears to be as follows: (1) The value of the net annual production, per head of persons engaged in the industry, for any one commodity, tends to fluctuate in the same way as for any other commodity; this agreement is much closer than for prices. (2) These fluctuations in the value of net annual production are due to fluctuations in the value of the money standard. (3) The value of the net annual production per head, at any one time, tends to be nearly the same for all commodities, including the money standard. (4) Wages and salaries tend approximately to the same proportion of the net annual production per head. (5) It follows from (3) and (4) that the annual wage-rate in any industry tends to be equivalent to the *net* annual production of gold per head for the same grade of labour in the gold-mining industry. (6) The approximately constant proportion of wages and salaries to total net annual product is due to the competition of unemployed labour; the maintenance of this pool of unemployment is the real failure of capitalism.

It should have been obvious even to unpractised writers that ordinary terms should not be employed in senses widely divergent from common usage. This rule has not been followed. The value of the net annual production per head of any commodity is spoken of throughout as its "normal price," with the result that the argument falls at times—for the reader if not for the authors also—into the most hopeless confusion. The reader comes across some phrase about "normal commodity prices"—dissents from it—passes on—and only perhaps some time later when wearied with an argument that seems to him nonsense may it occur to him that the authors did not mean normal prices at all, in the ordinary

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sense, but net annual products. Nor is the reader's understanding helped by careful consistence in the use of the term. On p. 116 we read: "This normal price consists in the number of articles produced per person (labour unit) multiplied by the money price," which suggests a gross and not a net product; but on p. 142, "when we take the normal prices which are based upon the unit of labour, we find that this price, *which is the price the producer gets*. . . ."—our italics. On p. 205 we find a clear statement that it is really the net product which is wanted, but on p. 303 we read "normal price is the market price or price per unit, multiplied by the quantity produced." The authors have only themselves to thank if few readers have the patience to stand much loose writing of this sort.

Frankly, this is a pity. For to the present reviewer there seems something to be said for the constructive argument of the book, though very little for much of the criticism contained in it. The argument might have received more attention if concisely presented, with unnecessary criticism eliminated. G. U. Y.

Our Bookshelf.

The War List of the University of Cambridge, 1914–18. Pp. xiv+616. (Cambridge: At the University Press, 1921.) 20*s*. net.

In his address to the Senate of the University of Cambridge, delivered on October 1, 1915, the retiring vice-chancellor, Dr. M. R. James, spoke of the services which members of the university were giving in their country's need. He said: "We are debtors to all. . . . Yet the university bears them upon her heart and will not, I know, neglect to perpetuate the memory of them." No public memorial has, indeed, been raised to their memory, but a noble record has been given to the world by the publication of this volume, which will carry far and wide the names of those members of the university who served with his Majesty's forces.

The volume has been prepared under the able editorship of Major G. V. Carey, of Clare College, and it is based on the lists published from time to time by the *Cambridge Review*, the materials for which came from the various college records. The syndics of the University Press took over the records in December, 1919, and since that date every name has been checked by the official Service Lists. Faced with the task of deciding which names were to be included, it was determined that residence prior to war service should be the criterion, with the exception of those who were prevented from going into residence in October, 1914, by reason of their having joined the forces; further, only those names which appeared in the various Service Lists have been included. This necessarily excludes the names of many who performed valuable and distinguished national service in other capacities, but it is obvious that to obtain an accurate record doing justice to all is almost an impossibility.

The volume concludes with an alphabetical index to the names, and a comprehensive summary—in itself a task of considerable magnitude—giving, for each college and for the whole university, the number of men who served, the number killed in action, the number of honours, etc. The first total is 13,878, and the second 2162—figures which show what a great part the university played in the war, and she has commemorated them worthily in this handsome list.

Meteorological Office—Air Ministry: British Rainfall, 1920: *The Sixtieth Annual Volume of the British Rainfall Organization*. Pp. xxviii+285. (London: H.M.S.O., 1921.) 12*s*. 6*d*. net.

Rainfall statistics over the British Isles have in no way suffered by the transfer of the collection and discussion of the observations from private to public control. The present annual volume is the sixtieth issued, and the second published under the management of the Meteorological Office. The war occasioned some diminution in the number of observers, but a considerable recovery from this is shown, the number now being 4952, an increase of 54 on 1919. A column is added to the detailed observations, giving the number of wet days or days with 0·04 in. or more of rain, and for the present the rain days or days with 0·01 in. of rain are also given.

Standard average values for the period 1881–1915 are used for the first time in "British Rainfall," and these are in agreement with the averages in use by the Meteorological Office in its various publications. Monthly average maps are given for the new period now introduced.

The distribution of total rainfall for 1920 is shown by a map as a frontispiece. Maps of monthly and seasonal rainfall are given, and the peculiarities are well described in the letterpress. Droughts and excessive rains are discussed, and there is much valuable information on evaporation and percolation in 1920.

Special articles are given on the new averages by the Superintendent of the Rainfall Organization, and also on the presence and distribution of salt in the air over the British Isles, by Mr. Wilfred Irwen, and on the Nipher rain-gauge shield, possibly of use where over-exposure is experienced.

Rainfall for 1920 was generally in excess of the average except in the eastern districts of Great Britain. The results for the droughty year 1921 will be of great interest. C. H.

Geography: Physical, Economic, Regional. By J. F. Chamberlain. (Lippincott's School Text Series.) Pp. xviii+509. (London: J. B. Lippincott Co., 1921.) 15*s*. net.

Essentially this book is an account of the earth, its surroundings, and its products in relation to man, but, since it is addressed particularly to

citizens of the United States, nearly all its illustrations, verbal and pictorial, are taken from North America and the possessions of the United States, and all the references, with few exceptions, are to American writers. In view of the fact, admitted by the author, that "the future history of America is to be inseparably connected with that of the rest of the world," more attention might have been directed to other countries; for instance, some of the street-scenes in American cities might have yielded to views in European or Asiatic capitals. It is, however, right that geographical study should begin with the home region, and this idea frequently finds expression in the inquiries suggested at the end of each chapter—*e.g.* "Make a careful study of the influence of geographic environment in your own State or locality. What factors are the most important? Are there any national forests in your State? Locate them. Is the Federal Government aiding in road construction in your vicinity?" But other suggestions will broaden the reader's outlook—*e.g.* "How will the economic geography of France be changed by the restoration of Alsace-Lorraine? What made possible the shipping of meat and dairy products from Australia and New Zealand to the British Isles?" These questions cannot be answered from the book itself. He who succeeds in answering them all will have had to read and think much, and will have become a more valuable citizen.

Modern High-speed Influence Machines. By V. E. Johnson. Pp. viii + 278. (London: E. and F. N. Spon, Ltd., 1921.) 14*s.* net.

THE author points out that electrostatic machines are used much more on the Continent and in America than in this country, where they do not appear to be held in good esteem. He proceeds to argue that this bad repute is undeserved, and proceeds to investigate the capabilities of this class of machine and the conditions upon which its efficiency and trustworthiness depend. Practically all the types which have been proposed from time to time are described and analysed, and accounts are given of the author's own experiments, resulting in a type considerably more efficient than the well-known Wimshurst machine. He claims that, as a source of high potential supply, a high-speed influence machine designed on the right lines should be as efficient as an induction coil with all its accessories, and that, principally on account of the continuity of its supply and the higher voltage available, it should give better results for Röntgen-ray work, particularly with tubes for high penetration. Other fields in which he suggests that such machines may prove useful include applications to wireless telegraphy, electro-culture, electro-therapeutics, ignition, and the testing of materials.

Although we find here and there a little looseness of expression and vagueness in quantitative statement, there is evidence of clear thinking in the construction of a consistent theory of the action of these machines from the mass of incomplete explanation which is diffused among the existing literature on the subject. There is also some thoroughly practical information as to the construction of these machines.

The Transition Spiral and its Introduction to Railway Curves. By A. L. Higgins. Pp. viii + 111. (London: Constable and Co., Ltd., 1921.) 6*s.* net.

THE early part of this book is devoted to a discussion on the principles underlying transition curves. The objects of a transition curve on a railway are to provide a gradual increase in curvature from zero at the point of contact of the curve and the straight part of the line of rails to a curvature equal to that of the central circular portion of the curve, and also to provide for a corresponding increase in the superelevation. Special attention is given to the clothoid (or Glover's spiral) $\lambda = m\sqrt{\phi}$, and the mathematical work required to elucidate this curve is carefully and clearly explained. The conditions which govern the lengths of transition curves are adequately discussed. The engineer may be called upon to insert transition curves in existing lines of railway and also in new lines, and for either purpose he will find the explanations of the procedure given in this book of great service. The latter half of the book is entirely taken up with field exercises fully worked out, which include not only the ordinary problems, but also problems in compound curves and reverse curves. This part is especially valuable, and cannot fail to be of use to railway engineers. We can recommend this book with confidence both to students of surveying and to railway engineers.

The New Hazell Annual and Almanack for the Year 1922. By Dr. T. A. Ingram. Thirty-seventh year of issue. Pp. xlvi + 585. (London: Henry Frowde, Hodder and Stoughton, Ltd., 1922.) 5*s.* net.

THE new volume of Hazell's Annual will receive a cordial welcome from all who have occasion to make use of reference books. It is smaller by about two hundred and thirty pages than the volume issued last year, the sections dealing specifically with the Overseas Dominions and with foreign countries having been omitted, but the omission has enabled the publishers to make a handsome reduction in the price. We also miss several of the interesting surveys of the progress in particular subjects during the previous year which have hitherto been included. Other features of past volumes, such as the calendars, astronomical and meteorological data for the current year, and a compilation of the particulars of societies and institutions, which includes most of the better-known British and foreign learned societies, have been retained. A large amount of educational information which covers the universities, colleges, and secondary schools in the British Isles has also been gathered together. The volume is a valuable book of reference on matters of general interest.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Some Problems in Evolution.

SINCE I am not, in the ordinary meaning, a biologist, I have sometimes difficulty in understanding biological language. Doubtless, also, I am often ignorant of recent developments in knowledge and thought. But certain problems of disease and education interest me, and I cannot get on with them unless some points, essentially biological, are cleared up. In the hope of enlightenment I wrote to NATURE. Immediately the discussion became acrimonious: at least, I became acrimonious. I was told, in effect, that I had no business in the august deliberations of biologists. It is not in human nature, or my variety of it, to accept that pontifical attitude. However, there seems now some prospect of the desired lucidity, and I shall be very ready to accept it with an humble and a contrite heart.

I fear, however, that Dr. Cunningham's letter in NATURE of January 12 does not greatly help. He writes:—"Sir Archdall Reid argues, as though it were a remarkable discovery, that characters are not present as such in the fertilised ovum from which an organism develops." But is that quite fair? I argued only that if, *as all biologists are aware,* no characters as such are present in the germ, then it must follow that, in the case of any and every character, nothing but germinal potentiality (predisposition, diathesis, capacity, ability) to produce (in response to fitting nurture) can be transmitted; whence it follows further that all characters are alike as regards innateness, acquiredness, and inheritability; whence, again, it follows that if we classify characters *with respect to these qualities,* there is, as Prof. Goodrich says, only one kind of character. On the other hand, *as all biologists know* (I protest I do not claim this as a new discovery), there are two kinds of variations: (*a*) those which result from germinal, and (*b*) those which result from nurtural, differences.

Of course, we can classify characters in all sorts of ways, useful and useless—according to colour, weight, size, shape, obviousness of recapitulation, frequency of reproduction, and so on. In a classification which physiologists have found useful, characters are ranked according to the influences which cause them to develop. This tabulation has the merit of forcing the inquirer to bear in mind the plain truth that frequency of reproduction depends (except when germinal variations occur) altogether on the frequency with which fitting nurtures are experienced, and not at all on the frequency of inheritance. For example, under this scheme of classification the inquirer bears in mind that rose comb and single comb in poultry are not more inheritable than corns on oarsmen's hands, but that they are more frequently reproduced only because the proper nurture is more frequently experienced. With respect to inheritance, his mind is fixed on the nature of the individual (the germ-plasm); with respect to reproduction, on the nurture received. Moreover, the student is compelled to realise that when he transfers the distinguishing terms "innate," "acquired," and "inheritable" from likenesses and differences between individuals to the characters in which those likenesses and differences are revealed, he has shifted his ground. It is one thing to compare separate individuals, and quite another thing to compare characters which may occur in the same individual. The old terms may still be applicable; but that is the question which has been raised. It will be gathered that they do not seem applicable to me, and that their constant and (to me) inexplicable transference is one of the causes of my puzzlement. It may be noted also that Darwin, in all that remains permanent of his work, used these terms in relation to variations, while Lamarck and Weismann applied them especially to characters. I may be mistaken, but I believe that I am right when I say that no one (including Darwin) has ever doubted the all-sufficiency of natural selection unless he has, in his thinking, transferred the terms "innate," "acquired," and "inheritable" from variations to characters, or has confused inheritance with reproduction.

Again, we may employ our words with unusual meanings and reason on that basis. Thus "inherit" may be used in the sense of "reproduce," when, of course, the "intensity of inheritance" of combs is infinitely greater than that of corns. But now we are asking for trouble and in sight of confusion. We are in danger of using as counters in thought and discussion, not realities in nature, but mere words. Our inquiries, notwithstanding our language, relate not to the natures of individuals, but to their nurtures. Does or does not the impure dominant inherit the recessive trait which it does not reproduce? Does the pure extracted recessive which is unlike its parent inherit nothing? When a pigeon or a fowl belonging to a fancy breed reproduces the wild ancestral coloration, from whom does it inherit? From an exceedingly remote ancestor? It passes my non-biological comprehension to understand how an individual can inherit except through, and therefore from, his parent. In practice the difficulty is surmounted by using "inherit" with the usual, or with the unusual, meaning as exigencies of argument dictate. For example, Dr. Cunningham employs the word with the ordinary meaning when he declares "a character may be inherited when it is apparent only in one parent or in neither," and with the unusual meaning when he insists that combs are more inheritable than corns.

Consider the Lamarckian dictum: "Acquired as well as innate characters are inheritable"; and the neo-Darwinian: "Innate, but not acquired, characters are inheritable." What do "innate" and "acquired" mean here? No one can tell. Definitions are impossible, for none can be framed which cover the whole of common and accepted usage. What does "inherit" mean? When applied to "innate" characters it may have, as already indicated, its ordinary meaning, or it may mean "reproduce." If a cock reproduced a comb under the same conditions as those in which its parent produced it (in response to similar nurture) all biologists would regard the comb as inherited—and rightly, for reproduction *under the same conditions* implies inheritance, though inheritance does not necessarily imply reproduction. The case is different with respect to "acquired" characters. If a child reproduced an oarsman's corn under the same conditions as the parent produced it, few biologists would regard the corn as inherited. It would be regarded as inherited only if the child developed it under conditions in which the parent did not and could not have developed it. The word now means "vary," *i.e.* non-inherit, for non-inheritance *is* variation. It seems, then, that an acquired character is not inherited when it is inherited, and is inherited when it is not inherited—*i.e.* a single word in a single sentence has two con-

trary meanings. Biologists say they understand one another, and therefore I suppose they do; but I wish, in pity, they would enlighten me. Why do Lamarckians and neo-Darwinians say "inherit" when they mean "vary"? Why do Mendelians and biometricians say "inherit" when they mean "reproduce"? Meanwhile, I cannot help suspecting that something is wrong. Consider what has happened—Lamarck's theory and half a century of stasis; Darwin's brilliant lucidity and twenty years of progress, with biology in its splendour, a great intellectual force; Weismann's effort, and nearly half a century of controversy, with interest in the subject limited to some (not all) zoologists and botanists, and of these few a majority resentful of trespassers.

I propose in two or three letters to adopt the physiological classification when dealing with three or four biological subjects. Biologists, I hope, will be tolerant towards one who uses this classification because, admittedly, he does not understand the difficult language they speak. G. ARCHDALL REID.

9 Victoria Road South, Southsea, January 16.

Atmospheric Refraction.

DR. BALL is surely wrong in suggesting in NATURE of January 5, p. 8, that the difference between Mr. Mallock's figure for the radius of curvature of a nearly horizontal ray and that given by Dr. de Graaff Hunter is accounted for by any consideration of the curvature of the wave-front. If such were the case, then an observer looking towards the sea horizon would see a ray of light in different directions for different initial curvatures of the wave-front. Suppose an observer from the bridge of a ship were looking at a searchlight placed at sea-level at the extreme limit of visibility. The rays of the searchlight beam would be plane waves, those coming from the barrel of the searchlight spherical. Does Dr. Ball wish us to infer that in such circumstances the visible beam would appear to the observer to issue from a point *above* the projector?—for that is what his suggestion leads to.

To my mind, a great deal of the confusion between refraction figures given by different authorities lies in their attempt to connect refraction with variations of temperature before they have properly considered the subject from the point of view of variations in refractive index. If we assume that, over the sea at all events, the refractive index stratification is one which is spherical and concentric with the earth, then the general equation of any ray of light is

$$pn = \text{constant},$$

where n is the refractive index and p the perpendicular upon the tangent to the ray from the earth's centre (see Herman, "Geometrical Optics," p. 305, or Heath, "Geometrical Optics," p. 329).

If r is the distance of any point upon the ray from the earth's centre, h the height of the point above the earth's surface, and R the earth's radius, then $r = \mathrm{R} + h$.

Now n must be some function of the height $= f(h) = f(r - \mathrm{R})$, and hence the "$p, r$" equation of the ray is

$$pf(r - \mathrm{R}) = \text{constant} = \mathrm{C}.$$

The radius of curvature of the ray is thus

$$\sigma = r\frac{dr}{dp},$$

$$= -\frac{r\{f(r-\mathrm{R})\}^2}{\mathrm{C}} \Big/ \frac{df}{dr},$$

or

$$= -\frac{rn^2}{\mathrm{C}} \Big/ \frac{dn}{dh}.$$

As we are dealing with a ray which is nearly horizontal, variations in r and n^2 cannot have large effects upon σ. The variations in r might amount to 1 part in 200,000 if the ray never gets above 100 ft. above the surface of the sea; the refractive index, which at the sea-level is 1·00029, could scarcely be reduced below 1·00027 in the same height, so that variations in n^2 could not exceed 4 parts in 100,000. It follows that the curvature of such rays is essentially proportional to the refractive index gradient. Since by Dale and Gladstone's law $n - 1$ is proportional to ρ, the density, the curvature of the ray-path becomes immediately proportional to the density-gradient. If we attempt to translate density-gradient into temperature-gradient, I see no means of doing so other than by making the assumption that the atmosphere is statically in equilibrium, in which case the formulæ given in my letter in NATURE of January 5 result immediately. But I have the gravest doubts of the legitimacy of such an assumption for the lower levels of the air. A steady motion leading to a dynamical relationship between pressure, density, and temperature is much more likely, but is, from the mathematician's point of view, a hopeless thing to try to set down owing to the impossibility of dealing with all the factors of the problem, such as rate of radiation of heat-energy from the earth or sea, rate of thermal conduction in the air, nature of the upward air-currents, and so on.

If however, we leave all such considerations aside and deal only with the established connections between curvature of the ray-path and the density-gradient, then we can only admit uniform curvature if we are prepared to admit that the density of the air in its lower levels is a linear function of the height. To such an admission I take the strongest exception. It is quite insufficient to account for a refraction of the visible sea horizon above the true horizontal—a phenomenon which, as every seaman knows, is by no means uncommon. T. Y. BAKER.

Admiralty Research Laboratory, Teddington,
Middlesex, January 7.

The Colours of Tempered Steel.

THE well-known and characteristic tints that appear on the surface of a tarnishable metal when it is heated in contact with air have been usually regarded as interference colours due to the formation of a thin film of oxide on the surface of the metal. The correctness of this explanation has, however, recently been questioned (A. Mallock, Proc. Roy. Soc., 1918), and rightly so, as a continuous film on a strongly reflected surface cannot on optical principles be expected to exhibit such vivid colours as those observed.

I have recently made some observations which shed a new light on this subject. It is found that the *missing colours* complementary to the tints seen by reflected light appear as light *scattered* or *diffracted* from the surface of the metal. In other words, if a plate of blue-tempered steel be held in a beam of light and viewed in such a direction that the regularly reflected light does not reach the eye, the metal shows a straw-yellow colour, and not the usual blue. It will be understood that the scattered light, being distributed over a large solid angle, appears much feebler than the regularly reflected colour, and in order to observe the effect satisfactorily the metal should have a smoothly polished surface before being heated up. Scratches and other irregularities show the ordinary colour of the film, and not the complementary tint. The most attractive effects are those exhibited by a heated copper plate, both on account of the vividness

of the colours and on account of the ease with which the surface can be given a satisfactory polish.

It is clear from the observations mentioned above that the colours under discussion are in the nature of *diffraction effects* arising from a film which is not continuous, but has a close-grained structure. Interesting effects are observed when the surface of the illuminated plate is viewed through a nicol, the colour and intensity of the scattered, as well as of the regularly reflected, beams varying as the nicol is rotated about its axis. The most striking effect is obtained when the direction of observation is nearly parallel to the surface of the plate. The scattered light in this case is nearly completely polarised, and the colour of the regularly reflected light changes nearly to its complementary when the nicol is turned through 90°. The phenomena strongly recall to mind the observations of R. W. Wood on the colours of a frilled collodion film on a silvered surface, which have been discussed by the late Lord Rayleigh (*Phil. Mag.*, November, 1917), and it seems probable that the explanation of the phenomena will ultimately be found to be somewhat similar in the two cases.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta, India,
October 11.

MR. MALLOCK has shown that the colour of the oxide film is an *intrinsic* property of the material of which it is composed and the material retains this property as it is gradually ground down from its original thickness to the vanishing point. Sir George Beilby's observations have confirmed this, and have further shown that the film is an aggregate *in open formation* through which oxygen molecules can penetrate to the metallic surface. For each temperature above the tempering range the thickness of the film is determined by the porosity of the aggregate to the oxygen molecules at that temperature. Direct experimental observations have shown the part played by *time of heating* at any given temperature. For example, at 275° C. a deep purple was reached in ten minutes, and this changed to blue from the margin inwards during a further period of twenty minutes. It was thus shown that the watchspring-blue, which could immediately be produced by a temperature of 300° C., could also be produced by heating at 275° for thirty minutes. Sir George Beilby's view is that the *intrinsic* colours of the films which are produced at different temperatures result from changes in molecular aggregation in relatively open formation of a similar nature to those which have been shown to occur in thin metal films, *e.g.* gold. This is referred to in his recently published volume entitled "Aggregation and Flow of Solids," sections 3 and 10.—ED. NATURE.

Some Terrestrial Experiments on Gravitation and Einstein's Theory.

THE object of this letter is to direct the attention of writers on Einstein's theory of gravitation to some recent experiments on the terrestrial aspects of gravitation which seem to have been overlooked, although they appear to be of great importance for the purpose of forming a just estimate of the correctness of Einstein's theory.

The first investigation referred to is that of Dr. P. E. Shaw on the effect of temperature on gravitative force (Phil. Trans., 1916, A, vol. 216, pp. 349–92). On p. 390 Dr. Shaw writes:—"When a large mass attracts a small one, the gravitative force between them increases by about 1/500 as the temperature of the large mass rises from, say, 15° C. to 215° C." The only cause capable of producing this effect on the relativity theory seems to me to be the absorption of heat by the large mass (lead), amounting to 6 calories, or $2\cdot5\times10^8$ ergs per gram, and resulting in a fractional increase of inertial mass of about $2\cdot8\times10^{-13}$. We require 7000 million times this amount in order to account for Dr. Shaw's result on the hypothesis of the proportionality of the gravitative and inertial masses, which is one of the basal assumptions of Einstein's theory.

Another investigation is that of Majorana on the absorption of the gravitational flux (*Phil. Mag.*, vol. 6, No. 39, pp. 488–504, 1920), in which he finds, *inter alia*, that a lead ball weighed *in vacuo* loses $7\cdot7\times10^{-10}$ of its weight when it is surrounded symmetrically by 104 kg. of mercury. If the gravitational flux be assumed to be absorbed by the mercury according to an exponential law of density and thickness, the *quenching constant*, or factor of absorption, is found to be $6\cdot73\times10^{-13}$ per unit density and length. A possible interpretation is that the gravitational mass of a homogeneous sphere at an outside point is only a fraction of its inertial mass; according to Majorana, it is about one-third for the sun. If this interpretation be legitimate, the results of Majorana, like those of Shaw, lead to the conclusion that the gravitational and inertial masses are not proportional to one another in all circumstances.

G. A. SCHOTT.

University College of Wales, Aberystwyth,
January 5.

British Scientific Instruments.

IN the timely and encouraging leader in NATURE of January 19, with which my experience is in entire agreement, there is a point of some importance to which reference is omitted. This is the practical question of cost. I would ask permission to draw a moral for application at the present time. Without expressing any opinion as to whether this cost could be reduced by improved methods of manufacture, I would direct attention to the fact that in the impoverished state of the finances of universities and similar bodies it is impossible adequately to equip their laboratories with costly apparatus.

The moral is this: *The most effective way in which Government intervention can assist British makers of scientific apparatus is to increase the grants to universities and to research in general.* It is impossible for individual workers to purchase expensive British instruments out of their own incomes, and until the resources of the laboratories in which they work are sufficiently increased it is an unjustifiable and foolish restriction to prevent their obtaining from abroad apparatus often admittedly inferior, but capable of good use. How many laboratories can afford to obtain Hilger optical apparatus or the Cambridge string galvanometer? It is further to be remembered that as science advances the instrumental equipment for continued pushing forward tends to become more elaborate, sensitive, and accurate, and necessarily of greater cost

W. M. BAYLISS.

University College, London.

Globular Lightning Discharge.

THE following is an account of what appears to have been a genuine case of globular electrical discharge observed by the sisters of one of my colleagues, the Misses Pitman, at Eastbourne on August 17 last. Authentic instances of this phenomenon are rare, and as the conditions which accompanied this particular

ball were observed with some care it seems desirable to put the case on record.

The two ladies were sitting at table about 8 p.m., with the window open. It was raining heavily at the time, and there was no wind. Stormy clouds were about, but it was not unusually hot. Thunder and lightning at the same time were afterwards reported from London—a distance of, say, 50 miles—but there was no thunderstorm at Eastbourne. There had been no rain during the few preceding days. As one of the ladies took up a knife to cut bread the ball of light was seen to flash past the knife (without touching it) on to the table, travelling a distance of about 9 in. at an average height of about 3 in. from the table, but moving towards the latter.

When the ball touched the tablecloth it "went out with a spitting sound," leaving no mark or trace of any sort. Until it touched the cloth there was no sound, and the whole thing was over in such a "flash of time" that it was impossible to say how fast the ball travelled. There seems to have been an impression that the ball came from the direction of the open window, but it was only under dependable observation during its 9-in. path from the bread-knife to the tablecloth.

As to the appearance of the ball itself, it was "about the size of a pea, the light encircling it being about the size of a golf ball. The light was white and intensely bright, like electricity." "Too dazzling to see through." A. P. CHATTOCK.

The University, Bristol.

Where did Terrestrial Life Begin?

FOR a long time now the idea has prevailed that life began in the sea or in the mud of the seashore, and many interesting articles have been written to describe the emigration of sea-creatures and water-creatures to the land, but there are some difficulties in the way of this theory which do not seem to have been noticed, and on broad general grounds it is, perhaps, more probable that life began on mountain-tops.

Life became possible on the earth only after it had cooled to a certain point, and surely that point was reached much sooner on hilltops than in the sea or on the seashore. It must be remembered that the sea when first formed would have a temperature of more than 100° C., since the condensation of volcanic steam must have taken place under a massive atmosphere of carbon dioxide. This heavy atmosphere would not only raise the boiling point of the sea, but would greatly retard its cooling, which would in any case be a very slow process, since the sea-bed would be hot and the sea deep, and a bad conductor. Would not the mountain-tops have become cool and habitable centuries before the temperature of the sea fell to 111° F. and became a fit abode of life? Further, it is almost certain that the first life was green chlorophyll-carrying cells which would require sunlight, and sunlight would pierce the heavy and cloudy atmosphere of steam and carbon dioxide, and would reach the hill-tops long before it reached sea-level.

For these reasons it seems that life is more likely to have made its first appearance on the mountain-top of the Polar regions than in sea-mud or sea-water. RONALD CAMPBELL MACFIE.

DR. MACFIE's suggestion that life originated on the mountain summits is new, and entitled to careful consideration. If the early earth, when its atmosphere was laden with carbon dioxide and steam, had been windless, then the mountain summits would have stood like islands above a sea of hot mist, and they would have been the only situations possible for the development of life; but as any wind would have at times submerged the mountain summits beneath the lower atmosphere, they would have been subject to violent fluctuations in temperature and moisture which would have been unfavourable to primitive life. It may be doubted whether life could have appeared on the earth until later, when the temperature and the atmosphere were more similar to those which have existed throughout all the time of which there are contemporary geological records as to climate and geographical conditions.

In the discussion on this question in a chapter of "The Making of the Earth" I laid stress on an equable environment as an essential condition for the development of Protobion, the most primitive form of life. If that view be sound, then life was not likely to have developed until a considerably later stage on the earth than that at which the conditions stated by Dr. Macfie would have held. His letter involves the issue whether the first life was semi-aquatic or terrestrial. On his assumption that it is "almost certain" that the first life consisted of cells containing chlorophyll it would certainly have begun on land. But such an organism would be more complex, and, therefore, probably later in development than some simple form of amœboid or mycetozoon, to which strong sunlight would have been less beneficial, and for which the unchanging environment on the muddy shores of a primeval lagoon would appear to be a more suitable medium than a mountain summit.

J. W. GREGORY.

Rainfall and Drainage at Rothamsted in 1921.

IN view of warnings that are being issued by various water companies that waste of water should be avoided, the rain and drainage figures of the Rothamsted Experimental Station for 1921 are of considerable interest and significance. The drainage gauges were built in Barnfield in 1870 by Lawes and Gilbert, and contain undisturbed soil which is kept bare; each gauge measures 1/1000 acre. The soil is a rather heavy loam with a reddish subsoil over chalk.

	Rainfall	Percolation.		
	1/1000 acre gauge. Inches.	Through 20 inches of soil. Inches.	Through 40 inches of soil. Inches.	Through 60 inches of soil. Inches.
For year 1921	16·093	5·766	5·984	5·479
Average for 50 years ...	28·692	14·834	15·482	14·659

The significance of these figures is that not merely is the rainfall and drainage the lowest since the records started, but that whereas in a normal year about 50 per cent. of the rainfall evaporates, during the past twelve months as much as 63 to 65 per cent. evaporated. This is partly accounted for by the excess of sunshine, which at this station amounted to 159 hours above the average, or about 26 minutes a day.

The number of days on which rain fell (0·01 in. or more) during the past twelve months is 119; this compares with an average for sixty-eight years of 174.

It is interesting to recall the fact that the year 1902, which hitherto gave the lowest percolation figures, was followed by the wettest year on our records, when the heavy rain-showers gave a drainage of 24 in. W. D. CHRISTMAS.

Rothamsted Experimental Station, Harpenden, January 16.

Tribal Name of the Raninidæ.

In the report of the Linnean Society's meeting on December 15 last the abstract of an elaborate and highly important essay by Prof. G. C. Bourne on "The Raninidæ: A Study in Carcinology" contains a proposal to place the family "in a separate tribe, Gymnopleura."

It would seem, however, that the name for such a tribe has been anticipated by Latreille, who, under date 1831, in his "Cours d'Entomologie," p. 368, institutes the tribe Notopterygia expressly for the genus Ranina. Attention has been directed to this in the comparatively recent year 1908 in the Annals of the South African Museum, vol. 6, p. 17. The same page explains that the specific name in *Ranina dentata* is founded on a mistake, and the preceding page, while giving a wrong date to the Mantissa of Fabricius, will by its synonymy justify the substitution of *Ranina raninus*, Linn., in preference alike to *R. scabra* and *R. dentata*.

THOMAS R. R. STEBBING.

Tunbridge Wells, December 22.

I AM far from a scientific library and unable to verify Mr. Stebbing's reference to Latreille's classification of the Raninidæ, but have not the least doubt that the reference is correct. There is no reference to Latreille's tribe Notopterygia either in Milne Edward's "Histoire Naturelle des Crustacés" or in de Haan's "Crustacea" in Siebold's "Fauna Japonica," and as I was concerned rather with the correction of existing schemes of classification than with the work of earlier authors, Latreille's "Cours d'Entomologie" escaped my attention. Had I read it I should have suggested the restoration of Latreille's tribe, giving to it the new definition set forth in my memoir communicated to the Linnean Society, and it seems that my proper course will be to withdraw the name "Gymnopleura" and substitute that of "Notopterygia, Latreille," in an addendum to the printed paper.

G. C. BOURNE.

Twyning Manor, Tewkesbury, December 30.

The Depth of Earthquake Focus.

In the Philosophical Transactions of the Royal Society, Series A, vol. 222, pp. 45–56 (1921), Mr. G. W. Walker, relying on certain observations of the emergence-angle of P waves at Pulkovo, makes the somewhat startling suggestion that the depth of focus is of the order one-fifth of the earth's radius, or about 1250 km. This is a much larger estimate of depth than that hitherto suggested, viz. of order less than 100 km. Mr. Walker's estimate of depth is a consequence of accepting the Pulkovo numbers as correct. It appears that the values of the apparent angle of emergence calculated from Zöppritz's curve do not agree with its value directly measured at Pulkovo. This discrepancy is so marked that either the time-curve or the Pulkovo values must be seriously in error, and Mr. Walker proceeds on the assumption that within the limits of possible error in the time-curve we can modify it so as to agree with the direct measure of the apparent angle of emergence.

It appeared to me that in a matter so important independent proofs would be desirable, and an attempt has been made to obtain an estimate of depth from the following considerations:—For a very deep focus, the long-wave phase in the seismogram or the "main strock" identified with the arrival of Rayleigh's two-dimensional surface-waves would be of diminished importance compared to the P and S phases which are due to the three-dimensional longitudinal and transverse waves travelling by brachistochronic paths from focus to station, in view of the fact that the surface-waves are originated by the shocks in the epicentral region. These shocks in their turn are due to the arrival of the longitudinal and transverse waves from focus to the epicentral region, and these waves, varying as they do as the inverse powers of the distance, make the shock in that region of lesser and lesser intensity the greater the depth of the focus. Consequently, the depth to be chosen for the focus must be of such a magnitude that the observed relationship between the principal phases in the seismogram is maintained. It has been found possible to calculate the effects of various focal depths on the relative importance of the different phases in the seismogram by an extension of the procedure adopted by Lamb in determining the propagation of tremors on the surface of an elastic solid (Phil. Trans., A, vol. 203, 1904). The investigation suggests that the hitherto accepted estimate of depth of focus is much nearer the truth than Mr. Walker's estimate. The detailed calculations will be published in due course.

S. K. BANERJI.

University College of Science, Calcutta, December 22.

Energy Changes Involved in Transmutation.

In some recent discussions concerning the possibility of the transmutability of large amounts of one element into others—and particularly that of lead into gold—no mention has been made of the energy changes involved. Studies in radio-activity and the work of Sir Ernest Rutherford have shown that whenever an element breaks up a relatively enormous quantity of energy is liberated.

Should it ever become possible to control the breaking up of elements, the advantages to be gained will lie in two main directions. First, the manufacture of elements now scarce from those more plentiful will be of the utmost value to industry. Secondly, the fact that intra-atomic energy will then be available should provide a satisfactory solution to the problems raised by the world's dwindling sources of power.

But if the energy available in this way is ever extensively used, all the heavier elements will be destroyed and gradually replaced by lighter; at the same time their available energy will be lost. So it appears possible that after countless ages the earth may become a mass of light elements, possibly in the condition of a nebula.

It has been assumed above that it would be possible to control the decomposition of elements so that only a limited amount of energy was liberated at a time. It is of some interest to contemplate what will happen should this evolution of energy get out of hand.

Let us suppose that someone has succeeded in starting the rapid decomposition of a block of a heavy element by the use of some accelerating influence. If the energy liberated during the action can escape faster than it is set free, no violent action is to be expected; but if, on the other hand, it is liberated faster than it can escape, an action of explosive violence may occur. The accumulation of energy will certainly increase the rate of decomposition of surrounding atoms, which in their turn will add still more energy, and the change will go on with ever-increasing velocity until the whole block of the element is destroyed. Should the surrounding elements be unable to stand up against the enormous quantity of free energy at their surfaces, it seems that nothing could save the earth from complete destruction. Thus inadvertently the world might be reduced by some enterprising chemist or physicist to a white-hot nebulous mass.

I. W. WARK.

43 Vincent Square, S.W.1.

The Theory of the South-West Monsoon.

By L. C. W. BONACINA.

IN the widest sense the term "monsoon" in climatology is applicable to those seasonal modifications, or subversions, of the planetary circulation which are established by the differences of temperature due to the irregular distribution of land and water, especially as seen in such regions as Eastern and Southern Asia, where a definite continental outflow of air in winter, and inflow in summer, characterise the surface circulation.

In relation to India the expression "south-west monsoon" is nowadays quite a commonplace, but it cannot be said that the theory of the phenomenon has hitherto been properly elaborated. The text-books commonly describe the monsoon as a kind of magnified sea-breeze action, an explanation of a complex phenomenon which can stand only as a first approximation. It must be emphasised, indeed, that the south-west monsoon of India is not in the main a special local effect of the heated condition of India at all, but is part of a general circulation of air with respect to a system of low barometric pressure originating primarily in the heated condition of the vast Asiatic continent as a whole. It is when one abandons a merely qualitative conception of the monsoonal circulation and considers the latter in the form which it actually takes as a wind-system of particular direction, speed, and structure that the mechanism is realised to be much more complex than is suggested by the above simple statement. For, just as one cannot understand the many puzzling peculiarities of the small-scale diurnal sea-breeze effect familiar round the English coast in summertime without referring to the general barometric-gradient wind of which it is often nothing more important than a coastal modification in direction and speed, so one cannot properly deal with the large-scale seasonal sea-breeze effect in monsoon countries otherwise than as an item in a wider system of circulation. This outlook is the key to the problem, and has enabled Dr. G. C. Simpson[1] to present meteorologists with the most effective analysis that has yet appeared. He shows the futility of trying to explain the monsoon in terms of a single cause, and the necessity of seeing in the phenomenon the final result of a number of interacting factors.

Before stating Dr. Simpson's theory, it may be well to review the main seasonal divisions of the Indian year. These are: (1) a cool, dry season, November to February, definitely dominated by the north-east monsoon, which really belongs to the north-east trade system as regulated at this season by high barometric pressure in Central Asia; (2) a hot, dry season, March to May, characterised by light air-currents gradually changing round from north-east to south-west,

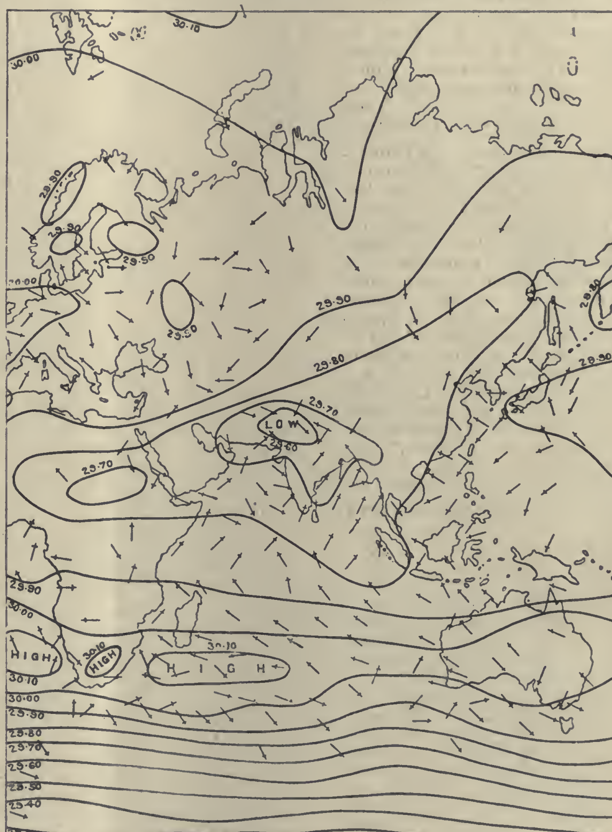

FIG. 1.—Average wind and pressure distribution around India in May. Pressure in inches.

[1] "The South-West Monsoon. Lecture delivered to the Royal Meteorological Society, March 16, 1921, and published in the Society's Journal for July, 1921.

culminating in unstable conditions productive of violent thunderstorms; (3) a wet season, June to September, dominated by the south-west monsoon, a powerful current bringing heavy rainfall everywhere in India except the north-west corner and those parts situated on the lee side of the mountain ranges; (4) a short transition period embracing the month of October, during which the south-west monsoon is retreating with belated rains on the Madras coast.

Now, in order to strike at the root of the prevalent misconception that the south-west monsoon current is due essentially to the heated surface of India itself, Dr. Simpson points to the outstanding seasonal anomaly in the climate of India. The anomaly in question is the fact that the hottest month of the year in India as a whole is not July, but May, coming, that is to say, just before the high solstice, instead of just after, as in England and most countries. The mean day and night temperature for the whole of India in May is 88·7° F., with a large part of the northern central region more than 90°, whereas in July the mean is only 83·5°, with the area more than 90° relegated to the Thar Desert in the north-west.

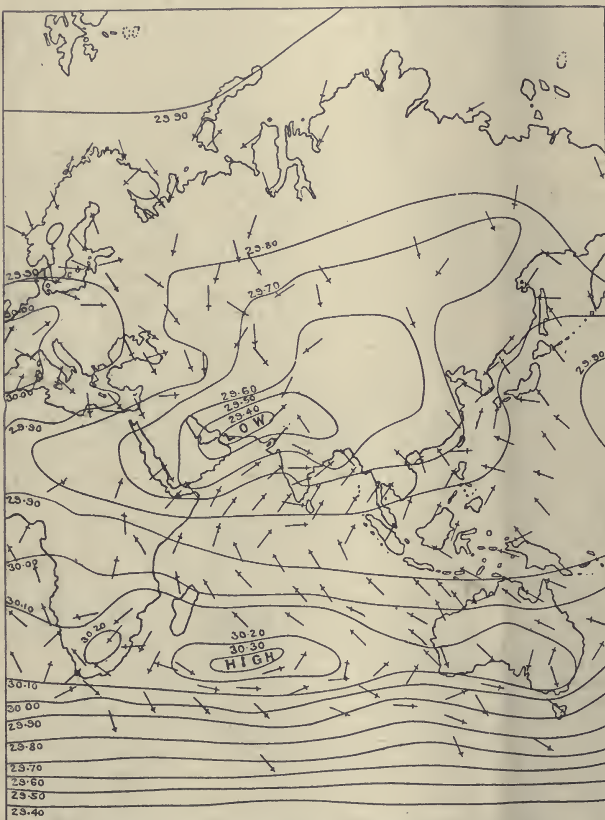

FIG. 2.—Average wind and pressure distribution around India in July. Pressure in inches.

Clearly, in all the more northern portions of India which lie away from the nearly non-seasonal equatorial regimen controlling the climate of Ceylon and the extreme south of the peninsula, the temperature ought to continue rising until July, and the fact that after May it appreciably declines is evidently the result of the cutting off of sunshine by the dense canopy of cloud and rain rolled in by the south-west monsoon. Why, then, does not the south-west monsoon burst in May? Because in that month the summer low-pressure system to the north-west of India is not in a sufficiently advanced stage of development. It is not until June that this low-pressure area and, contemporaneously, the high-pressure area in the South Indian Ocean become pronounced enough to induce the south-east trade wind to cross the equator, thereby to become deflected by the rotation of the earth into the current which feeds the south-west monsoon. The difference is illustrated in Figs. 1 and 2, which show the average distribution of wind and pressure over a large area surrounding India in May and July. The difference between the two maps will be brought out more fully in relation to the monsoon rainfall. Meanwhile, let there be noted what is exhibited with much greater distinctness in maps[2] of wind and pressure for India alone, that in both months, but more conspicuously in May, the isobars, with corresponding deflection of the wind arrows, bend southward in crossing the Indian land-mass—away, that is to say, from the centre of low pressure in the north—signifying that there actually is some indraught due to India itself, though it is only a superposed secondary feature, giving the isobars their precise trend—a local modification of the general Asiatic circulation.

Now to explain the great meteorological characteristic of the south-west monsoon, viz. the heavy rainfall. The diagram Fig. 3 was devised by Dr. Simpson to represent the chief alignments of mountains in and around India (thick-lettered lines), and the chief air-stream lines of the south-

[2] See Dr. Simpson's original paper, and Sir John Eliot's "Climatological Atlas of India."

west monsoon current (numbered arrows). It should be studied in relation to Fig. 4, showing

FIG. 3.—Chief alignments of mountains, and air-stream lines of south-west monsoon, in and around India. (After G. C. Simpson.)

the mean rainfall over the same area in July, the typical monsoon month. The disposition of the mountain ranges is such as very effectively to entrap in a kind of box the humid air brought into the Indian area by the south-west monsoon, with the consequence that the air is mechanically forced to ascend with copious condensation of moisture as a result of cooling by adiabatic expansion. Where the ranges obstruct the air-currents at right angles, as in the case of the Western Ghats, KL, or the Khasi Hills, HI, enormous falls of rain occur during the four or five months of the wet season. The Khasi Hills, moreover, contain a spot, Cherrapunji, so peculiarly favourable to orographic precipitation that the average annual rainfall is as high as 424 in., nearly all of which falls during the monsoon period. In the Gangetic Plains the heavy rainfall is largely due to the convergence of air-streams III., IV., V., and VII., assisted by the Himalayan wall, CD, at the base of which the forced ascent of air causes another specially wet submontane strip of country.

The dry areas in July are mostly in the "rain-shadow" of the mountains, but the desert region in the north-west of India is nearly rainless for a complexity of reasons—partly because the trend of the neighbouring mountains is not such as to force upward the comparatively small amount of air which flows into this corner of the country; partly because, with the initial conditions thus unfavourable to cloud production, what little air does arrive there from the sea is heated up so that its relative humidity is lowered and the tendency to drought consequently increased; and partly because over this part of India the upper-air current from the north-west, as revealed by direct kite observations, is warm and dry, a condition most unfavourable to condensation of moisture in any surface air that may be caused to rise. In the burning-hot Thar Desert a number of interacting factors thus conspire to maintain intense drought during what in India generally is the rainy season.

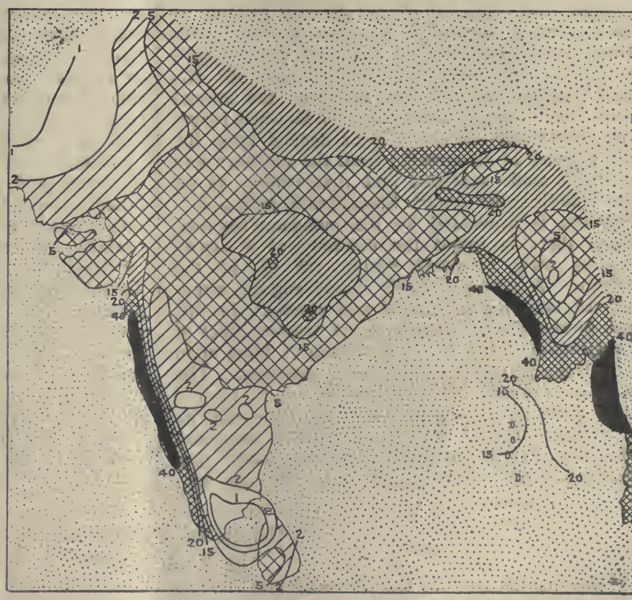
FIG. 4.—Average rainfall (in inches) of India in July.

The reason why the mountains provoke so enor-

mous a rainfall out of the monsoon current of July, and scarcely any out of the indefinite sea-winds of May, is shown by Dr. Simpson to be twofold—the July winds are both markedly stronger and damper. At Bombay, for example, the mean wind velocity is 7·4 miles per hour in May and 14·2 in July, and the relative humidity 74 and 86 per cent. respectively. Consequently, when a wind from the Arabian Sea mounts the Western Ghats, condensation will for two reasons proceed more actively in July than in May. Referring to Figs. 1 and 2, it will be seen that the pressure-gradient over India is steeper in July than in May, which means stronger winds, and that the powerful monsoon current of the former month is supplied from the south-east trade wind, with the result that the air which reaches India, after traversing some 2000 miles of sea, is necessarily very humid. In May, on the contrary, the light winds on the west coast blow somewhat north of west and conflict with the south-east trade wind over the equatorial part of the Indian Ocean, where rain falls instead of in India.

Realising how illusory charts of mean monthly meteorological conditions may be as representing actual conditions on any particular day, Dr. Simpson is able to show that the circulation in the Indian area rarely differs essentially from the mean, and that breaks in the monsoon are associated with temporary reversions to the conditions typical of May, when clear skies and fierce sunshine are broken only by violent local thunderstorms.

One cannot but support his conclusion that without the mountains the general rainfall of India would be lighter, if more evenly distributed. Those who argue that in any case the southern portion of the peninsula, below about 18° N., would experience the full effect of the annual northward swing of the equatorial rain-belt forget that the steady equatorial rains depend upon the convergence of air-streams from the northern and southern trade systems, and that where, as on the Benadir coast (Italian Somaliland), such a convergence is prevented by the monsoon regimen itself, there is found the anomaly of a nearly rainless strip of coast within 10° N. of the equator. A problem which should engage attention as facilities for travel and research in this part of the world increase is the precise effect of the Himalayas and the high plateau of Tibet upon the strength of the south-west monsoon. The effect of a broad, cold tableland 10,000 ft. high is more likely to be negative than positive—that is, to weaken rather than to strengthen the monsoon. The late Prof. Herbertson, whose insight into climatological questions was not perhaps adequately appreciated by meteorologists, used repeatedly to discountenance exaggerated notions concerning the "flue-like" action of Central Asia often entertained by those who rely too much on isothermal maps reduced to sea-level. In any case, there would be a general inflow of air towards Asia in summer, as is so well exemplified in China; but the real controlling centre of the powerful south-west monsoon of India is situated near the mouth of the Persian Gulf, and it is this "cyclonic" centre which guides the air-currents across India to the base of the Himalayas, which they must perforce mount, and thence on to the highlands of Tibet.

To summarise, the primary condition of the south-west monsoon is a centre of low barometric pressure situated to the north-west of India, due to the heated state of this region in summer, and to a certain extent of the Asiatic land-mass as a whole. The special local effect of India itself is quite subsidiary, merely serving to give the isobars and air-currents across the peninsula their final trend. In May the local heating of India, then at its maximum, does not suffice to bring about monsoonal conditions, but the general Asiatic heating in July does, for reasons discussed. A heavy rainfall accompanies the monsoon because it is both a humid and a powerful current, and is met more or less at right angles by various high mountain ranges.

Finally, it is advisable to refer to certain general principles in connection with the theory of the monsoonal circulation, the importance of which is duly emphasised by Dr. Simpson. Whilst it is a conspicuous fact that, broadly speaking, the continents command high pressure in winter and low in summer, and the oceans *vice versa*, the more detailed relationship between pressure and temperature is exceedingly complex, and the precise location of a centre of high or low pressure depends upon many other factors, such as the rotation of the earth and the configuration of the land. In other words, the atmosphere being a unity of interdependent parts, it is largely a matter of compromise, as between region and region, what type of circulation shall prevail here and what there. To take but an instance. Nothing is more perplexing than the drought-producing wind and pressure regimen of the Mediterranean basin in summer with intense insolation and active evaporation to a meteorologist who conceives of this region as isolated from other regions, and forgets that the Mediterranean circulation has to adapt itself to the great monsoon system of Asia, as well as to the conditions in other parts of the world.

Helium in Natural Gas.

By H. B. Milner.

THE researches of H. P. Cady and D. F. McFarland in 1905 on some natural gas from Kansas led to the interesting discovery of the presence of helium in that gas, a fact of which advantage was taken afterwards by the United States military authorities during the later stages of the war. In 1915 the natural gas resources of this country were investigated for a similar purpose

under the direction of the late Sir William Ramsay, and those of Canada were also examined, but in both cases the efforts were unsuccessful. The dangers attending hydrogen-filled aircraft were obvious from the fate of many of the German Zeppelins, so that the possibility of extracting sufficient quantities of an incombustible gas such as helium (admirably suited in every way to the peculiar requirements of lighter-than-air machines) was too important to be ignored.

In the United States the help of certain commercial firms, employing the Linde and Claude processes of gas liquefaction for the treatment of air, was solicited, and in 1918 two plants were in operation at Fort Worth, Texas, ultimately giving an average production of 5000 cb. ft. of gas per day, yielding on purification up to 93 per cent. of helium. Although the effect of the armistice was to check military requirements, the development of commercial aviation keeps this use of helium very much in the foreground, and in view of this and also of the far-reaching scientific problems involved the United States Geological Survey has just published, from the pen of G. Sherburne Rogers, a most valuable monograph on "Helium-bearing Natural Gas" (Professional Paper 121, 1921).

The chief region from which commercial supplies of helium are obtained is that of the Mid-Continent oilfields, more especially from two areas, one in North Texas and the other in North Oklahoma and South Kansas; gas in both these areas yielded up to 0·5 per cent. of helium, in some cases the amount being as much as 2 per cent. One would naturally expect helium-rich gas to show a high nitrogen content with consequent low calorific value; generally speaking this is found to be so, though in one instance a gas with 14 per cent. of nitrogen yielded 0·35 per cent. of helium. On the other hand, a high nitrogen content is not necessarily a criterion of a high helium yield, and Rogers cites several examples of this. The nitrogen–helium ratio in natural gas in thirteen samples quoted ranges from 114 to 20; the conclusion to be drawn from this, and also from a careful study of several other available analyses, is that a low (N_2He) ratio implies a low helium content.

The richest helium-bearing gas in America is obtained from comparatively shallow depths in the Pennsylvanian beds, and it is interesting to note that gas emanating from younger beds, such as the Cretaceous or Tertiary of Texas and Louisiana, is low in helium content. Bearing in mind Czakó's contention that the radio-activity of a gas is an index of its helium content, and also Holmes's work on radio-activity as a measurement of geological time, it is thus not difficult to appreciate the reason of the low helium content of European natural gas, derived for the most part from Tertiary strata. Evidence is not forthcoming as to the radio-activity of the gas from the Pennsylvanian beds, but McLennan's researches in Ontario (Nature, vol. 70, p. 151, 1904) demonstrated the tendency of decreased radio-activity with increased depth, and this may reasonably be correlated with the marked decrease in helium yield with increase in depth from which the gas is obtained in the present case.

The origin of the helium in the gas affords a wide ground for speculation, though in the present state of our knowledge it would be very unsafe to dogmatise. Rogers discusses this at some length, but of the several possible theories he favours two, more particularly the first—that the helium is generated from uranium or thorium deposits disseminated through the beds proximate to the natural gas horizons, or that it is primordial and comes from abyssal sources. His arguments in favour of the former theory are very sound, though, as he admits, it assumes the occurrence of radio-active deposits of which we have no knowledge, more particularly in the upper palæozoic rocks of the Mid-Continent region, or in some of the buried igneous masses occurring as subterranean uplifts.

It is interesting to note that in the case of the three principal occurrences of natural gas in this country, at Calvert, Buckinghamshire, at Middlesbrough, Durham, and at Heathfield, Sussex, the nitrogen contents were 19·5 per cent., 16·8 per cent., and 0·9 per cent. respectively; in the first case the source of the gas is doubtful, but it is presumably from pre-Liassic beds; in the second case it is obtained from the Magnesian Limestone, and at Heathfield it is unquestionably derived from the Kimmeridge Clay. If the nitrogen evaluation is any indication of helium-bearing gas, as it would seem to be in the United States, it is extremely unlikely that helium occurs in those gases in amount greater than 0·5 per cent. (if as much as that) at Calvert and Middlesbrough, while at Heathfield it is probably absent altogether.

Obituary.

Lord Bryce, O.M., F.R.S.

It can be but seldom, when a man's life has been prolonged to well over eighty years, that his death is generally felt as a serious public loss. Lord Bryce's sudden, if happy, death on January 22, in his eighty-fourth year, is a shock which will be felt equally here and in the United States, where only last summer he had been engaged both by lecturing and in social intercourse in spreading a better understanding of the problems of Great Britain and Europe. Years ago, by his great work on "The American Commonwealth," and at a later date by his tact and manifold activities while our Ambassador at Washington (he was reputed to have visited every State in the Union), Lord Bryce had made himself a living link between the two peoples. In the United States he was not only trusted by statesmen and appreciated by the leading men in thought and literature, but he was also an idol of the crowd. When he came into a popular assembly the proceed-

ings were apt to be interrupted and the whole audience would stand up and give three cheers for "good old Bryce." Among themselves the Americans to the last habitually called him "our Mr. Bryce." American citizens of all classes believed in his thorough goodwill towards their country, and he thus achieved what seemed almost the impossible in inducing them to bear kindly with criticism they felt to be both honest and friendly. For if Lord Bryce knew no better form of government than democracy, he was, as his recent work has shown, keenly alive to its imperfections and crudities both in the States and in Australia.

Politics, historical and literary studies, and travel were the main occupation of Lord Bryce's life. His career in the two former branches of activity has been fully dealt with in the general Press. Here we may more appropriately confine ourselves to the last. Lord Bryce, without being in any strict sense a man of science, though he was elected a fellow of the Royal Society, under the special rule, in 1893, took the keenest interest in several branches of natural science. His father had been a geologist, and he himself was apt to record the geological features of the countries he passed through. In botany he was an eager student, with a keen eye for rarities. In his walks near his home at Ashdown Forest he would frequently stop to recognise some relatively rare growth, and so long ago as 1859 he wrote a manual on "The Flora of the Island of Arran."

When he visited Pekin the attachés at the British Legation, who were prepared to give information on Chinese politics, were dismayed to find themselves called on to answer questions as to the local flora. In his "Impressions of South Africa" he discusses at some length the vegetation of the country, and records that he brought home fifty-four plant specimens, eleven of which were pronounced at Kew to be new to science. Wherever he went he was as keenly interested in the natural aspects and features of the country visited as in its inhabitants and their politics, and he delighted to trace the interaction between the two. His descriptive talent was exceptional, and was aided by the almost unique opportunities for comparison given him by the extent of his travels. Take at hazard this vivid sketch of Lake Titicaca:—

"The blue of Titicaca is peculiar, not deep and dark, as that of the tropical ocean, nor opaque, like the blue-green of Lake Leman, nor like that warm purple of the Ægean which Homer compares to dark red wine, but a clear, cold, crystalline blue, even as is that of the cold sky vaulted over it. Even in this blazing sunlight it had that sort of chilly glitter one sees in the crevasses of a glacier; and the wavelets sparkled like diamonds."

The shortest way to indicate the extent of Lord Bryce's travels might possibly be to give a list of the regions he had *not* visited. During the three years (1899–1901) when he was president of the Alpine Club it was noted that whatever distant range might be under discussion the ubiquitous chairman was sure to begin his remarks with, "When I was out there." I believe "The Mountains of the Moon" was one of the few places where the author of the paper had the advantage of him.

Of these many years' wanderings and holidays in a busy life (continued until last spring by a trip to Morocco) the public have had the results in three solid works. Of these, the first, "Transcaucasia and Ararat" (1877) was in the main not a mountaineering record, but a study of the Caucasian isthmus and its peoples, as seen by a passing visitor. But the account of an ascent of Mount Ararat, in which Lord Bryce reached the top without his companions, fixed public attention and had some singular consequences. In a rash moment he wrote of a piece of wood he picked up near the top, a relic of a previous Russian ascent, that he was not able to state it might not be gopherwood. When in the United States he had frequent applications from out-of-the-way local museums for the smallest fragment of this invaluable relic of Noah's Ark!

Lord Bryce's two solid volumes on South Africa and South America are, apart from their political importance, admirable pictures of the regions described. In their pages he unites the power of observation which makes a good traveller with that of generalisation which is called for in a geographer. And he carries his readers on from one topic to another by a lively style which reflects the quickness and versatility of the author's mind. Lord Bryce was engaged at the time of his death in a collection of "Memories of Travel," which we trust will be found in a state sufficiently advanced to admit of publication.

It must be added that if Lord Bryce had one hobby, or taste, stronger than another, it was for mountains and mountain climbing. He habitually found time to attend the meetings of the Alpine Club, and to take a share in its discussions. He followed the doings of its members with the keenest interest. The chief ornament of a study which was usually a chaos of proofs, letters, and presentation volumes, was a photograph of the most beautiful of snowpeaks, the Himalayan Siniolchum.

DOUGLAS W. FRESHFIELD.

SIR JOHN KIRK, G.C.M.G., K.C.B., F.R.S.

BY the death of Sir John Kirk at the advanced age of ninety, the world has lost the last survivor of the heroic pioneers of African exploration, the founder of the British position in Eastern Equatorial Africa, and a botanist whose contributions to African natural history were of first-rate importance.

Sir John Kirk was born in the Manse of Barry, near Arbroath, in 1832. He entered Edinburgh University at the age of fifteen, and obtained the degree of M.D. in 1854. In 1855 he went to Turkey with the Volunteer Medical Corps in connection with the Crimean War and served in a hospital on the Dardanelles. In 1857 he was recommended by "Woody Fibre" Balfour as physician and naturalist to Livingstone's second expedition, in which he served from 1858 until he was invalided home in 1863. On that expedition, which was the least successful of Livingstone's three, Kirk gained a higher reputation than any other of its members. His unfailing good humour, tact, and great gift of

sympathy must have been invaluable, and in spite of internal dissensions in that expedition, Livingstone afterwards wrote that he had never had any difference with Kirk. Livingstone has borne warm testimony to Kirk's untiring zeal, energy, and courage. He collected 4000 species of plants, in addition to zoological specimens, making careful studies of the economic products. In gratitude for his help Livingstone named the western wall of the Rift Valley along the Shire River and Lake Nyasa, the Kirk Range.

Kirk returned to East Africa in 1866 as physician to the Consulate at Zanzibar. He was fortunately soon entrusted with political work, and became Vice-Consul in 1867 and Consul in 1873. In 1870 Said Barghash succeeded to the Sultanate, and the general impression of his character is summed up in Kipling's "from Said Barghash in a tantrum," but he was never in that condition with Kirk. Both men had a keen sense of humour, and Kirk soon gained an immense influence over Said Barghash, who was a loyal friend. When the Sultan was visiting this country in 1875 he threatened to return at once because he felt that Kirk had been treated rudely by the Duke of Cambridge. In 1873 the combined influence of Sir Bartle Frere's mission and of Sir John Kirk secured the abolition of the slave trade in the Dominion of Zanzibar. Sir Frederick Lugard has testified to the efficiency with which Kirk ensured the enforcement of that edict by the Slave Court at Zanzibar, while insisting on the missionaries taking no illegal premature steps in reference to domestic slavery. In 1877 the Sultan offered a British syndicate a lease of his dominion on the mainland; but the British Government would not accept the offer, and it was not until after Germany had secured the southern part of those territories that a concession of the rest was accepted, and the British East Africa Company founded to administer them. Kirk was one of the founders and original directors to whom the Royal Charter of that company was awarded. Its ultimate failure was one of his most bitter disappointments. The company was incorporated in 1888, and Sir John Kirk thenceforward lived in England. He served for many years as foreign secretary of the Geographical Society, which gave him its Patron's Medal in 1882. He was elected fellow of the Royal Society in 1887; he was also a D.C.L. of Oxford and Sc.D. of Cambridge.

Kirk's scientific work was mainly botanical. He was a most indefatigable collector; he described some of his new plants, and wrote many articles for the *Kew Bulletin* and other scientific journals. His collections have greatly enriched the Kew Herbarium, and have been described as amongst the most important materials for its "Flora of Tropical Africa." His main interest was in economic botany. He established at his own expense at Mbweni, near Zanzibar, an experimental plantation of which the results were of the highest value, and introduced many trees and plants, and some of the extensive eucalyptus plantations in East Africa came from seeds raised from his trees. He wrote reports on olive culture and on fibres, one of the valuable local supplies of which comes from *Sansevieria Kirkii*.

Kirk founded the East African trade in wild rubber, the best of which came from *Landolphia Kirkii*, and his name is also commemorated in many other important East African plants. He introduced through Kew a considerable series of new plants to British gardens.

After his return to this country he was regarded, until blindness lessened his usefulness, as one of the most trustworthy referees from the Foreign Office on African questions. In 1889–90 he was a plenipotentiary to the Brussels Conference, and for his services there was made K.C.B. His K.C.M.G. was awarded in 1881, and his G.C.M.G. in 1886. He was Vice-Chairman of the Uganda Railway Committee, and was sent to Nigeria to inquire into the famous case of sacrificial cannibalism when forty prisoners were eaten at Akassa.

The beautiful little antelope, "Kirk's Gazelle" (*Madoqua Kirkii*), will help to preserve his memory among settlers in the lands he secured to the Empire. To the explorers of that area Kirk was a friend who will always be remembered with most sincere affection and respect.

Prof. J. H. Cotterill, F.R.S.

On January 8 Prof. James Henry Cotterill died at Parkstone, near Bournemouth. Prof. Cotterill was the youngest son of the Rev. Joseph Cotterill, of Blakeney, Norfolk. Educated at Brighton College, he was afterwards apprenticed in the works of Sir William Fairbairn, at Manchester. Later he went to St. John's College, Cambridge, and took a fair place in the mathematical tripos. In 1866 he became lecturer and in 1870 vice-principal at the Royal School of Naval Architecture and Marine Engineering at South Kensington. In 1873 the school was moved to Greenwich, and became part of the Royal Naval College, in which Prof. Cotterill was professor of applied mathematics until his retirement in 1897. He was elected hon. vice-president of the Institution of Naval Architects in 1905.

In 1806 a commission had recorded the opinion that the highest officers then responsible for the design and construction of vessels of the Royal Navy were sadly ignorant of the theory of naval architecture, and, in fact, in the early nineteenth century the best ships in the Navy were those captured or copied from the French. In 1811 the first Admiralty School of Naval Architecture was opened at Portsmouth for training expert advisers, under Dr. Inman. It lasted twenty years, but trained only forty students, some of whom, like Isaac Watts, chief constructor, attained distinction. In 1848 a second school was opened at Portsmouth, under the principalship of the Rev. Dr. Woolley, and entry from the dockyard schools was made dependent on merit. It lasted only five years. Mr. E. J. Reed (chief constructor) and Mr. Barnaby (chief naval architect) were among its students on whom devolved the responsibility of the transition to ironclad construction. Chiefly at the instance of the Institution of Naval Architects, the third Admiralty school was

established at South Kensington, and this continues its good work as part of the Royal Naval College.

This institution had the great advantage that the Admiralty students from the dockyard schools were well prepared for advanced instruction. It has, through the distinguished careers of many of its students, exercised an important influence on the shipbuilding industry in this country, and on the development of the great Navy which commanded the seas in the late war. The organisation of the theoretical part of the instruction was mainly due to the ability, industry, and originality of Prof. Cotterill. An account of the courses of study is given in the later editions of his "Applied Mechanics." The school was open to private students, and some of these obtained important positions in private shipyards and in the constructive departments of foreign navies.

Prof. Cotterill's earliest papers were on least action, on the theory of propellers, and on the reaction of an elastic fluid escaping from an orifice. In 1878 he published a treatise on "The Steam Engine considered as a Thermodynamic Machine"; and in 1884, a treatise on "Applied Mechanics." Both these have passed through several editions, are still in use, and have much influenced the teaching of the subjects in engineering schools in this country and in America.

WE record with much regret the death on January 22, at seventy-six years of age, of Sir William Christie, K.C.B., F.R.S., Astronomer-Royal from 1881 to 1910.

Notes.

IN a letter to the *Times* of January 23 Mr. F. P. Mennell recalls his description of the bone-cave at Broken Hill, Rhodesia, published in the *Geological Magazine* in 1907, and adds some further details in reference to the recent discovery of *Homo rhodesiensis* in a deeper extension of the cave. He emphasises the fact that all the stone and bone implements found with this extinct cave man are such as are used to-day by the Bushmen and Hottentots in outlying places, while all the mammalian bones, evidently broken for food, belong either to living species or to species closely allied to those still existing in the neighbourhood. The Rhodesian man is therefore probably not so old as the primitive types of man who wielded the Palæolithic implement in western Europe. We may add that Mr. Mennell's original paper was referred to in NATURE of November 17 last by Dr. Smith Woodward, who also expressed the opinion that Rhodesian man would prove to be of comparatively recent date.

IT was resolved by the General Committee of Subscribers to the Rayleigh Memorial, after arranging for the erection of the tablet in Westminster Abbey, which was unveiled recently, "that the executive committee be empowered to use the balance for the establishment of a library fund at the Cavendish Laboratory." The amount subscribed to the memorial fund was 1575*l.*, and after defraying all expenses connected with the tablet the balance was 687*l.* 15*s.* 8*d.* In accordance with the resolution of the general committee, Sir Richard Glazebrook and Sir Arthur Schuster, secretaries of the fund, have now sent a cheque for this amount to the Vice-Chancellor of the University of Cambridge. The committee desires that of this sum 600*l.* should be treated as capital, the interest upon which is to be at the disposal of the Cavendish professor annually for the purposes of the library; the balance of the capital, namely, 87*l.* 15*s.* 8*d.*, may be drawn upon at once in order to bring the library up to date. It is suggested that a book-plate should be prepared connecting the books purchased out of the fund with Lord Rayleigh.

THE Père Lachaise cemetery in Paris, which has during the last few days witnessed several acts of homage to the memory of the great dramatist Molière, contains a large number of tombs and monuments of remarkable interest. Among these are many to the men of science of last century. The cemetery was laid out in 1804, and the monument to Molière was one of the first erected in it. Walking round the paths familiar names of statesmen, poets, musicians, writers, soldiers, and painters catch the eye at every turn. Science is represented by the mathematicians Poinsot, Monge, Hachette, and Charles; the astronomers Arago and Delambre; and the chemists Dulong, Gay Lussac, Chaptal, Boussingault, and Raspail. Comte, Cuvier, Bichat, Claude Bernard, and Geoffrey St. Hilaire are also commemorated. Quite close together will be found the tombs of Madame Lavoisier who made such an unhappy alliance with Rumford, and Madame Blanchard, the intrepid aeronaut who perished in 1819. Other pioneers in the conquest of the air whose names are perpetuated in the cemetery are Robertson, Charles, Croce-Spinelli, Gaston, and Tissandier.

FROM the *Daily Telegraph* we learn that the Paris Academy of Sciences has received an invitation, through Prof. Kriloff, a specialist in naval construction, to send representatives to Moscow to the celebration of the bicentenary of the Russian Academy of Sciences, to be held in 1925. Prof. Kriloff, in his speech, expressed the hope that science would throw solid bridges over the chasms made by war, and that the relations of all the peoples would be re-established with the same cordiality as before. The initiation of the Russian Imperial Academy of Sciences was due to Peter the Great, though its actual inauguration was carried out by his widow, Catherine I. It was she who invited the great mathematician, Leonhard Euler, to her capital, but her death occurred on the day Euler set foot on Russian soil. Joined by Daniel Bernoulli and the astronomer Delisle, Euler continued to work at Petrograd until 1741. His surroundings, however, were not always

congenial, and afterwards when a princess at the Court in Berlin asked him why he spoke so little, he replied: "Madame, parce que je viens d'un pays où quand on parle on est perdu." Euler continued to send memoirs to the Academy, and in 1766 he accepted the invitation of Catherine II. to return to Petrograd, and he died there in September, 1783. Some of his sons entered the Russian service, while his son-in-law, Nicolas von Fuss, became permanent secretary to the Academy.

ONE of the largest telescopes in the world, hitherto unused, is likely to be brought into service shortly, according to an announcement made at a recent meeting of the American Astronomical Society. It is a 60-in. reflector constructed by the late Dr. A. A. Common about thirty years ago and bought by the Harvard Observatory in 1902. It is exceeded in size by two telescopes only, both of them on the Pacific coast—the 100-in. reflector at Mount Wilson, in California, and the 72-in. reflector, the property of the Dominion Government, at Victoria, in British Columbia. A second reflector at Mount Wilson is of the same size as that at Harvard. The Harvard instrument was purchased for visual and photographic star measurements, but when set up and tested was found unsatisfactory for that purpose. It was therefore abandoned, and has ever since been stored away in the observatory grounds. Meanwhile, the science of astrophysics has provided an increasingly large number of problems, in which the light and heat from a star, rather than the size of a photographic image, are the things measured. It is for such problems as these that the Harvard telescope, with its 5-ft. mirror—once considered useless because it would not produce perfect images—is now to be employed.

AT the annual general meeting of the Royal Society of Arts, on June 30, 1920, it was announced that unless the society succeeded in purchasing the freehold of its house in John Street, Adelphi, it would be obliged to find new quarters after March, 1922. The matter was referred to again in the annual meeting on June 29 last, and the sum of 50,000*l*. was mentioned as the cost of buying and renovating the property. An appeal for subscriptions was therefore made in order to obtain funds to secure permanent possession of the historic house built for the society by the brothers Adam about 1775. So far, two lists of subscribers have been issued in the society's journal, from which it appears that the sum of 40,678*l*. has already been raised. Of this total no less than 30,000*l*. is due to the generosity of one anonymous benefactor. Other noteworthy subscriptions are 2,500*l*. from Sir Charles A. Parsons, and 1000*l*. each from Lord Bearsted, Sir Dugald Clerk, the Earl of Iveagh, Lord Leverhulme, and Mr. A. A. Campbell Swinton. The sum already subscribed should be sufficient to secure the continuity of tenure of the John Street house, which has been the scene of the society's labours for the past 147 years, but it is to be hoped that further contributions will be forthcoming, so that the whole of the purchase-money may be available, and also means for making desirable alterations in the meeting-room and other parts of the building.

AT the annual general meeting of the Royal Meteorological Society on January 18 the Symons gold medal, which is awarded biennially for distinguished work in connection with meteorological science, was presented to Col. H. G. Lyons. Dr. Charles Chree was elected president of the society for the year 1922.

DR. G. CLARIDGE DRUCE has recently been elected a corresponding member of the Botanical Society of Czecho-Slovakia "for his inestimable services to botanical science." The diploma is signed by the president of the society, Prof. Karel Domin, professor of systematic botany in the University of Prague.

ON Tuesday next, January 31, Prof. H. H. Turner begins a course of three lectures at the Royal Institution on "Variable Stars," and on Thursday, February 2, Sir Napier Shaw delivers the first of two lectures on "Droughts and Floods." The Friday evening discourse on February 3 will be delivered by Sir Francis Younghusband on "The Mount Everest Expedition," and on February 10 by Dr. Halliburton on "The Teeth of the Nation."

THE Civil Service Commissioners announce that an open competitive examination for not fewer than fifteen situations as assistant engineer in the Engineer-in-Chief's Department of the General Post Office will be held in London, Edinburgh, and Manchester in April next, commencing on April 20. The limits of age are twenty and twenty-five, with certain extensions. Regulations and forms of application will be sent in response to requests by letter addressed to the Secretary, Civil Service Commission, Burlington Gardens, London, W.1.

HAVING regard to the confusion which now exists, especially in overseas trade, due to the difference between the American gallon and the Imperial gallon, the Decimal Association urges that it is desirable for an agreement to be reached between the Governments of Great Britain and the United States to the effect that as an alternative to either of the above gallons being adopted by both countries as a common standard, each of them should forthwith adopt the litre, which could be described as the "metric gallon." It is obvious that uniformity of practice in a matter of this kind is most desirable, and the adoption of the metric gallon would not only standardise practice between Great Britain and America, but also with practically all other countries engaged in international trade.

A PORTRAIT of Sir Patrick Manson was unveiled by Sir James Michelli at the London School of Tropical Medicine on January 20. The portrait was subscribed for by a large number of past and present students and other friends at home and abroad. The painting was entrusted to Mr. E. Webster, and is a most pleasing likeness. It hangs in the vestibule of the school, where it will be seen by the large number of students attending the classes. Reproductions of the

portrait will be made by Mr. Malcolm Osborne, and will soon be ready for distribution. In recognition of Sir Patrick Manson's services as a clinician, money has also been subscribed for a medal, which will be awarded annually to those who distinguish themselves in clinical work. The medal will bear a portrait of Sir Patrick Manson by Mr. John Pinches.

THE programme for the Air Conference to be held at the Guildhall on February 7–8 has now been issued. During the morning of the first day of the meeting papers will be read by Lord Gorell on civil aviation, and Lt.-Col. W. A. Bristow on aerial transport of to-day and to-morrow. Papers on research work from the points of view of designers, constructors, and users by Major F. M. Green, on the progress of research by Brig.-Gen. R. K. Bagnall-Wild, and on airships by Major G. H. Scott will occupy the afternoon session. The whole of the second day of the meeting will be devoted to general discussions. In the morning Capt. F. E. Guest will preside, and civil aviation papers read during the previous morning will be dealt with; in the afternoon the chair will be taken by Lord Weir of Eastwood, and the technical papers of the previous afternoon will be discussed.

INFLUENZA had materially increased in severity, according to the Registrar-General's return for the week ending January 14. Deaths due to the epidemic numbered 1240 for the ninety-six great towns of England and Wales, an increase of 433 on the preceding week. In London the deaths were 551 for the week, an increase of 197 on the preceding week. During the great epidemic of 1918–19 the deaths from influenza in London amounted to 2458 in the week ending November 2 and to 2433 in the week ending November 9, but with the exception of the 1918–19 epidemic the death-rate is now higher than in any other epidemic of influenza since 1890, the nearest approach occurring in the epidemic of 1892, when for the week ending January 23 the deaths in London numbered 506. During the week ending January 14 the deaths between the ages of sixty-five and seventy-five were 21 per cent. of the total. Deaths from pneumonia and bronchitis have also considerably increased.

A SUMMARY of weather results for 1921 is given in the *Weekly Weather Report* of the Meteorological Office for the closing week of December, showing the mean and aggregate values for the several districts of the British Isles. There was a general deficiency of rain, the only districts with an excess being the north and west of Scotland, these districts having respectively 106 and 104 per cent. of the average fall. In the east of Scotland the rainfall for the year was 87 per cent. of the average, and in the north of Ireland 89 per cent., whilst in the north-west of England it was 86 per cent. In the north-east of England the rainfall was 73 per cent. of the average, and in the Midland Counties 69 per cent. The rainfall was only 48 per cent. of the average in the east of England, followed by 50 per cent. in the south-east of England, 54 per cent. in the English Channel district, and 60 per cent. in the south-west of England. The district having the largest amount of rain during the year was the north of Scotland with 54·34 in., while in the east of England the total measurement was 13·45 in., and in the south-east of England 13·84 in. The mean temperature for the year was above the normal in all districts; the greatest excess was 2·7° F. in the English Channel district and 2·5° F. in the north-east and east of England and the Midland Counties. The duration of bright sunshine was in excess of the average in all districts over Great Britain; the greatest excess was 0·7 hour per day, amounting to 250 hours for the year in the east of England and 0·6 hour per day in the Midland Counties and the south-east of England.

THE problem of the conservation of the coal resources of Great Britain involves the study and classification of the coal seams which are at present being worked or developed, and also of seams above or below ground which are being left unworked or are thrown aside. On its directly practical side this work must deal primarily with the suitability of each particular coal for those purposes for which its individual qualities render it most appropriate, and the Fuel Research Board believes that the most effective way of achieving this end is by the co-operation in local committees of colliery owners, managers, and consumers with the representatives of the Fuel Research Board and the Geological Survey. By this combination local knowledge and experience, as well as the initiative of those most deeply interested in the practical aspects of the survey, will be secured. Thus from the outset the survey will assume a practical character. The selected seams will be submitted to physical and chemical examination by the local experts, and as a result of this examination a further selection will be made of those which appear to justify experiments on a practical scale to test their suitability for particular uses or methods of treatment. This experimental work will be carried out either at H.M. Fuel Research Station or at other works, as may be found most convenient. A start has already been made in the Lancashire and Cheshire district, where the local research association has been recognised by the Fuel Research Board as its representative body for the purpose of dealing with the physical and chemical survey of the coal seams in this area. The chairman of the new committee is Mr. R. Burrows, and the director of research Mr. F. S. Sinnatt.

A LEADING article in the *Museums Journal* for December suggests as a remedy for the alleged overcrowding of the national museums that their redundant specimens should be transferred to the provincial museums, and asks for a Commission to consider the limits of our national museums and how far it is possible for them to assist the provincial and "Colonial" museums. In the January issue Mr. Williamson, of the Derby Museum, while admitting past help, would welcome gifts or long loans on a more systematic plan and with more reference to local

needs. Dr. F. A. Bather, while in agreement with the proposal, maintains that such transference is the policy of the British Museum, which is only prevented from carrying it out fully by inadequacy of staff. He also points out that the interests of scientific students demand the accumulation of large collections in as few centres as possible, and that the bulk of such material is not really redundant. Sir Frederick Kenyon in his presidential address to the Museums Association in July last expressed a wish to meet the needs of provincial museums if they would make them known.

DR. RAPHAEL KARSTEN, lecturer in the University of Helsingfors, Finland, has made an important contribution to anthropology in the first part of his "Studies in South American Anthropology." He deals more particularly with personal ornamentation, ceremonial mutilation, and kindred customs. The savage man's love for self-decoration has been discussed by many anthropologists. Darwin believed that the object of these decorations was to make man beautiful, and especially attractive to the other sex; W. Joest, while admitting that body-painting has a practical value in protecting the body from insects, heat, or cold, admits that the principal motive, besides inspiring enemies with fear in battle, is sexual desire, a view generally accepted by Westermarck in his "History of Human Marriage." Dr. Karsten believes that the part which magic has played in originating primitive customs has, up to recent times, been much underrated, owing to our defective knowledge of the psychology of savage man. This side of the subject is pursued in this monograph, which, though principally devoted to South America, discusses the question from other points of view, and, with its careful citation of authorities, deserves the attention of anthropologists.

NATIONAL laboratories for the cleaning, restoration, and preservation of antiquities have for some years existed at Berlin, Copenhagen, and Stockholm. Well-known books on the subject have been published by Dr. Rathgen (ed. 2, 1914) and Dr. Rosenberg (1917), the latter dealing with iron and bronze objects only. In our own country there was no laboratory for the purpose until 1920, when Dr. Alexander Scott was induced by the Department of Scientific and Industrial Research to direct the work of a small laboratory temporarily equipped at the British Museum (Bloomsbury). So far as the English language was concerned, G. A. and H. A. Auden's translation of Rathgen's first edition (1905), a chapter in Prof. Flinders Petrie's "Methods and Aims in Archæology" (1904), and a few articles in the *Museums Journal*, notably a well-illustrated one by Dr. Rathgen (1913), were about all the museum curator had to guide him. Now the Department just mentioned has issued a first report by Dr. Scott (Bulletin No. 5, 1921, 2*s*.). It deals with prints, enamels, silver, lead, iron, copper and copper alloys, and rock-paintings. Dr. Scott has attacked the problems *de novo*, and has evolved some new and ingenious methods. Their success is illustrated by some photographs "before" and "after."

A VERY complete summary on the subject of anthrax infection in man appears in the Bulletin Mensuel for November last of the Office International d'Hygiène Publique, Paris (t. 13, No. 11, 1921, pp. 1135–1239). Anthrax infection in man is most commonly seen as a cutaneous manifestion, the characteristic malignant pustule, which is caused by local inoculation. Internal anthrax also occurs in the lungs, intestine, and brain, and is caused by inhaling or swallowing the spores of the anthrax bacillus. Internal anthrax is always fatal, but the malignant pustule is fairly amenable to treatment, if taken in time, by anthrax serum or by excision. The disease is always transmitted from an affected animal, living or dead, or from the commercial products derived from an affected animal, such as skins and hides, goat, camel, or horse hair, and wool. Between 1915 and 1920 a number of cases of human anthrax due to shaving-brushes has been reported in England (49), United States (40), Holland, Italy, and Egypt, the brushes having been made with infected hair. In Holland few cases of human anthrax occur, less than a dozen per annum. The same is the case in Norway, in spite of the frequent occurrence of the disease in domestic animals, though among these the frequency of the disease is diminishing, from 686 animals affected in 1906 to 33 in 1920.

THE last report of the Grain Pests (War) Committee established by the Royal Society has now made its appearance. It required the conflagration of a European war and the threat of starvation to Britain to stir us to investigate some of the problems connected with the destruction of grain by insects. Though the committee set up by the Royal Society was purely a war one, it seems a pity that it should cease to act just when the fringe of the subject has been touched. Could the Royal Society not be induced to continue the investigations? The present report (No. 9) contains a short note by Prof. Goodrich on the parasitisation of certain grain beetles by Hymenoptera. It is shown that these parasites are not likely to prove of value as a means of controlling the beetles, as the chalcids are themselves kept in check by carnivorous acarids. The second part is by Dr. J. Waterston, who deals with the systematics of the parasitic Hymenoptera. These parasites are, like their hosts, cosmopolitan, and many of the species previously described were certain to fall as synonyms. This comprehensive and beautifully illustrated paper should prove the basis of future work. The last report is that by Mr. J. H. Durrant on the species of insects found in grain; hundreds of samples of grain were examined from different parts of the world. These are all tabulated, showing the species found in each. We note that several species of beetles are new to our lists of grain pests. Altogether, much useful information is contained in the report.

IN the November issue of the Journal of the Franklin Institute Dr. Carl Hering brings together some of the phenomena produced by the flow of heavy currents in conductors which have been observed in recent times, and points out that in

many cases they violate some of the laws of electromagnetism as stated in current text-books. He therefore pleads for a restatement of these laws in such form that there shall be no apparent exceptions to them. In the first instance, he points out that it is not sufficient for the production of electromotive force by magnetic induction that lines of magnetic force shall cut through a *circuit*, but that the lines must cut through a *conductor*. Further, he contends that the existence of the "pinch" effect, contracting the section of a conductor carrying current, of the "stretch" effect, lengthening the conductor, and of what he has named the "corner" effect, when a conductor changes its direction, render it advisable to modify the dictum that the forces on a conductor "can never have a resultant in the direction of the axis."

THE firm of Messrs. Barr and Stroud, which grew out of the remarkable inventive work of the partners, was from 1888 until 1918 mainly occupied with the manufacture of range-finders and other instruments relating to the gunnery requirements of many different countries. They have since turned their attention also to the small type of internal-combustion engine used on motor-cycles, and, as a consequence, have now put on the market an engine of 349 c.c. capacity working on the four-stroke cycle and having a sleeve-valve and air-cooling. The engine is made under the well-known Burt and McCollum patents and has several attractive features. The absence of all external valve mechanism makes for cleanliness and greatly lessens engine noise. It is a light engine, since its weight to horse-power ratio is, it appears, but 7 lb. per h.p. when giving the maximum power of 7 h.p. The sleeve has a double motion, both horizontal and vertical, so combined that any point in it moves in an elliptical orbit. It has five curiously shaped ports, two for inlet, two for exhaust, and one for the double purpose, serving each in turn. The general design is very attractive, and the claim for a special degree of ease in dismantling and adjusting appears to be substantiated by an examination of the details of the design. Tests on the road have shown a satisfactory degree of fuel economy.

DURING the past forty years many proposals have been considered by the authorities in New South Wales for providing suitable means of communication across Sydney Harbour to accommodate the growth and development of Sydney. Tenders and designs have now been invited for the construction and erection of a cantilever bridge. Some particulars of this project are given in an illustrated article in *Engineering* for December 30 last. The bridge will carry four lines of railway, a main roadway 35 ft. wide, a motor roadway 18 ft. wide, and a footway 15 ft. wide. The total length, including the approach spans, will be 3816 ft.; the headway required for shipping will be 170 ft. at high water for the central 600 ft. of the bridge. The bridge is to consist of steel cantilevers with shore and harbour arms each 500 ft. long and a central suspended span of 600 ft. The clear span from centre to centre of the main piers will be 1600 ft. For the information of tenderers a number of interesting tables is given, showing the range of temperatures and intensities of prevailing winds and the extreme velocities and pressures recorded during the severest storms in Sydney. Full particulars are also given regarding the loads to be employed in estimating and the stresses to be used. The specification has been prepared by the chief engineer, Mr. J. J. C. Bradfield.

THE council of the Chemical Society has issued a pamphlet of eleven pages dealing with the furnishing and equipment (so far as fixed fittings are concerned) of chemical laboratories as the result of a conference of various bodies interested called by the society eighteen months ago at, we believe, the suggestion of the Royal Institute of British Architects, though this is not mentioned. The object in view was to ascertain whether, in view of the high prices of labour and materials, economies could be effected in laboratory fittings. A small committee of the society was appointed and decided to investigate present practice, and the report gives information collected from various institutions. Though necessarily but a slight contribution to a very large subject, the report contains a useful epitome of the methods in use for forming and treating bench-tops, reagent shelves, fume cupboards, sinks, and waste channels, while notes on ventilation, supply services and floor and wall surfaces are added. Finally, a short bibliography is given on the subject of laboratories, upon which, however, there is very little literature. Laboratory fittings are always costly, and at the present time, when so much educational work is held up owing to lack of funds for its material development, any information which will enable those responsible for designing laboratory fittings to cheapen and simplify requirements is bound to be of service. As regards the use of wood particularly, it seems much to be desired that experiments be undertaken in order to ascertain whether many of the cheaper soft woods cannot, by impregnation or other suitable treatment, be made to serve in place of imported hard woods.

THE August issue of the Journal of the American Chemical Society contains an account of the separation of the isotopes of chlorine by diffusion, contributed by W. D. Harkins and A. Hayes. The work was begun in 1915, and has been carried out in the chemical laboratories of the University of Chicago. A preliminary account of the separation of a heavier fraction from hydrogen chloride by diffusion through the stems of tobacco-pipes was given in NATURE of April 22, 1920, p. 230. Calculations by Rayleigh's formula show that to produce an increase of 0·2 in the atomic weight would require the diffusion of 130 tons of hydrogen chloride gas. The relative amounts of the different isotopes are as important as the atomic weight differences, and it is shown that, contrary to what has been supposed, it is easier to produce a small increase in the atomic weight of chlorine than to produce the same increase in the atomic weight of neon. The diffusion was carried out through clay pipe-stems or tubes at atmospheric pressure. Low pressures would be more advantageous. The increase

in atomic weight amounted in different experiments to from slightly less than to considerably more than one part in a thousand. A considerable amount of the isotopic acid has been produced. These experiments seem to confirm beyond doubt the existence of the isotopes of chlorine first announced by Dr. Aston on the basis of positive-ray analysis. The latter method gives, in addition, the atomic weights of the two isotopes.

MESSRS. BENN BROS., LTD., announce for publication in March a work which should be of interest and value to many readers, viz. "The Early Ceramic Wares of China," by A. L. Hetherington, in which will be described the main characteristics of the products of the Chinese factories before 1368. The same publishers also promise a new series entitled "The Chemical Engineering Library," the first nine volumes of which will be The General Principles of Chemical Engineering Design; The Layout of Chemical Works, H. Griffiths; Materials of Construction: I., Non-Metals, H. Griffiths; Materials of Construction: II., Metals, H. Griffiths; Mechanical Handling, A. Reid; Weighing and Measuring Chemical Products, Malan and Robinson; Flow of Liquid Chemicals in Pipes, N. Swindin; Chemical Works Pumping, N. Swindin; and Factory Wastes as Fuels, A. Reid.

MESSRS. H. K. LEWIS AND CO., LTD., 136 Gower Street, London, have just issued an up-to-date list of "College Text-books and Works of Reference in Science and Technology." The titles are arranged under authors' names, and are classified under eighteen subjects, some of which, such as chemistry, engineering, etc., are again divided. The subjects are arranged alphabetically, whilst a contents-list on the first pages makes reference to any subject quick and easy. The list will be sent post free to any address on application.

Our Astronomical Column.

DEDUCTION OF STAR-DISTANCES FROM PROPER MOTIONS.—The proper motions are almost our sole guides in estimating the distances of the more remote stars. Hence any method that affords a check on the results is of value. Prof. H. N. Russell points out in the *Astrophysical Journal* for September last that we can estimate the distance either (1) by correlating the motion away from the solar apex with the sun's velocity, or (2) by correlating the cross-motion with the line-of-sight velocity. As a test he has divided the 180 stars of type B_0 to B_5, the radial velocities of which were found by Campbell, into eighteen groups, the mean position of each group being nearly the same. He finds for the general mean parallax 0·0083″ from (1) and 0·0058″ from (2). One reason given for the smaller value from method (2) is that some of the stars may be undetected spectroscopic binaries, in which case the adopted line-of-sight velocity is presumably too great. The probable error of result (1) is 0·0010″, of (2) 0·0014″. In general, method (1) gives the best results for objects of small average velocity like the B stars, while (2) is better for quick movers like the planetary nebulæ. The apparent close connection between period and absolute magnitude in the Cepheid variables was originally deduced from results obtained by method (1), and later obtained considerable confirmation from a study of the variables in the globular clusters, which appear to be mainly Cepheids.

METEORIC SHOWER OF DECEMBER 4–5, 1921.—Mr. W. F. Denning writes that he has received a communication from the Tokyo Astronomical Observatory, Japan, stating that an abundant display of meteors was observed there on the morning of December 5. Watching 55 minutes between 4.15 and 5.10 G.S.T. of Japan (December 4 between 7.15 and 8.10 G.M.T.), Mr. S. Inouye saw fifty or sixty meteors, and recorded the paths of forty-six meteors, among which forty-four radiated from about $156°+37°$ near β Leonis Minoris. The meteors were rather rapid, and the magnitudes ranged nearly from 2·0 to 4·5.

On the next morning Mr. Inouye watched 15 minutes, but no meteors belonging to the same radiant were observed.

Mr. S. Kanda calculated the following elements from the above radiant point, assuming the orbit to be parabolic:

$$\Omega=252{\cdot}1°,\ \omega=232{\cdot}6°,\ i=133{\cdot}3°,\ q=0{\cdot}791.$$

No comet is identified with these elements.

Mr. Denning adds that this shower in Leo Minor was well observed at Bristol on November 25–28, 1876, when he observed 26 meteors from the point $155°+36°$. The observation was reported in NATURE of December 21, 1876, p. 158. The shower was also seen by him on December 2, 5, 7, and 10, 1885, when the radiant point was redetermined at $152°+40°$.

The display witnessed at Tokyo on the night following December 4 last could scarcely have been well observed in England, for when the maximum occurred at 7.35 p.m. G.M.T. the radiant point was close to the north-north-east horizon, whereas at Tokyo it was situated only a few degrees east of the zenith, and splendidly placed for the abundant distribution of its meteors.

POPULAR ASTRONOMY IN SWEDEN.—The Stockholm periodical *Populär Astronomisk Tidskrift* continues to produce articles of much interest and practical value. Häfte 3 and 4, 1921, contain a useful illustrated article by Edv. Jäderin on the graphical prediction of eclipses and occultations. The methods are easy to follow and capable of an accuracy that is amply sufficient.

O. A. Åkesson discusses the periodicity and motion of sun-spots. The daily amounts of rotation for different latitudes are plotted for the two periods 1886–97 and 1898–1909. The values for the second period show a diminution of nearly 1 per cent. compared with the former. H. v. Zeipel contributes a study of the cluster M 37, near θ Aurigæ. He finds the colour-indices by comparison of photographic with photo-visual magnitudes, and deduces a distance of 1500 parsecs. There is also an illustrated article on the Babelsberg Observatory and its new refractor (aperture 65 cm.) and reflector (aperture 120 cm.), both made by Zeiss.

The approaching series of occultations of Aldebaran are the subject of a useful note. Accurate observations of the bright-limb phases of these phenomena will serve to test the conjecture that there may be a sensible atmosphere on the moon's sunlit face.

Physiology at the British Association.

THE outstanding features of this most successful meeting at Edinburgh were the large number of discussions and the giving of an official semi-popular lecture. Before the beginning of the latter a very pleasant interlude was furnished by Prof. Halliburton announcing a presentation to Sir Edward Sharpey Schafer on his seventieth birthday by his former students and co-workers.

The address of the president of the section was followed by a debate. Sir E. Sharpey Schafer discussed three points in connection with physiology, namely, the position of histology, physiology as a pure science, and physiology in relation to clinical medicine. He stated that anatomy is not a dead subject without histology, as it can be developed along the lines of morphology and embryology, but that histology is essential for the proper understanding of physiology. He further pointed out that, although it can be called microscopic anatomy, histology has developed as a branch of physiology. The study of physiology as a pure science is necessary, because it is in the pursuit of knowledge that discoveries are made. It is not always known what practical applications may arise for new knowledge, but by confining one's attention to purely practical applications the reserve of knowledge to be applied will become exhausted. The application of physiology to clinical medicine should come by the clinical teacher having held a position in the physiological laboratory. The physiologist has sufficient work to accomplish in his laboratory without attempting to become a clinician. By the proper training of clinical teachers in physiology it is hoped that invaluable applications will arise in medical practice.

A number of other speakers took part, all of whom enforced the views of Sir Walter Fletcher that physiology must be studied as a pure science in a university; that the physiologist should study the organism as a whole, so that histology, chemistry, and physics all may be applied to explain the behaviour of living organisms; and that it is only by a combination of all these that one can appreciate to what extent the chemical and physical processes may be regulated in the living cells.

Prof. A. R. Cushny opened a discussion on the relation of tests for studying the efficiency of the kidney to the views as to the function of the kidney. Various tests have been used to test the functional activity of the kidneys without a proper consideration of the conditions of its activity. The excretable substances must be distinguished from the non-excretable. The threshold substances are those which are excreted when their concentration rises above a certain threshold, and the no-threshold substances are those which are completely excreted, *i.e.* they are of no further use to the organism. Of the various substances used, water, chlorides, and urea are not satisfactory, as they are not completely excreted. By comparing the amount of urea and sulphate in blood and urine it has been found that sulphate is concentrated twice as much as urea, so that the functional activity as judged by the sulphate excretion would be twice as great as when judged by the urea excretion. Sulphate, phosphate, and creatinine were concentrated to equal degrees; therefore, the concentration of any of these in plasma and in urine might be measured as a test for functional activity.

Prof. J. Meakins commenced by agreeing that urea is not a toxic substance. He quoted cases where chronic incomplete obstruction of the ureter gave rise to a large volume of dilute urine. If temporary removal of the obstruction causes the kidney function to become normal, this is an indication for surgical interference; but if the excretion does not become normal, surgical interference is contra-indicated. Sometimes one finds that a no-threshold substance (*e.g.* creatinine) is being retained. Retention of urea by itself is not important, because along with this retention one may find such conditions as an excessive excretion of phosphates or a retention of chlorides, which are more responsible for the symptoms. The kidney does not function as a whole under abnormal conditions, and if one adheres too rigidly to one criterion of functional efficiency abnormalities may be overlooked.

Dr. J. S. Haldane expressed the view that under normal conditions the kidney regulates the diffusion pressure of water, but that under some abnormal conditions the level set by the kidney is not that required by the tissues.

Prof. P. T. Herring showed some slides of the skate's kidney, which demonstrated the direct excretion of substances into the kidney tubule. He stated that normally the kidney has a constant function, but in disease the function is variable, being influenced by other organs. A study of the comparative structure of the kidney in various animals may help to show how various parts of the kidney tubule function; part may be absorptive and part excretive.

Prof. A. Krogh (Copenhagen) pointed out that the concentration of urea is the same throughout the tissues, but that it may be present in different concentrations in the various secretions.

Prof. T. H. Milroy re-emphasised the uniformity in concentration of urea in blood and muscle. He added that an increase in concentration of urea in the blood is followed by a latent period before the extra urea is eliminated. The concentration in blood and muscle falls slowly to the former level.

Dr. C. L. Evans thought that local circulatory changes in different parts of the kidney might affect the excretion of different substances by different parts of the tubule. The circulatory changes in arteriosclerosis is a case in point.

Dr. E. P. Poulton stated that in the arterio-sclerotic kidney there is a marked difference between the two parts of the kidney and slight urea retention. In azotoic nephritis urea excretion is damaged, but the chlorides are not retained.

Sir James Mackenzie desired that more attention should be paid to the interrelation of kidneys and other excretory organs, such as the skin and bowels.

Prof. E. P. Cathcart opened a discussion on "Heavy Muscular Work." Heavy muscular work requires a co-ordination of the muscular, circulatory, respiratory, and nervous systems. In carrying out heavy work rest periods are important, but the data concerning the number and duration of them are not yet satisfactory. Overwork is prevented by two factors of safety, namely, fatigue, which is slow in onset and may be produced by any degree of work, and collapse, which is sudden in onset, probably due to heart failure, and not to lack of oxygen-supply to muscles. The former is hastened by monotony, such as in marching, and the latter occurs sooner if the work involves a static or maintained element. The effects of training and of diet are important in determining the power to carry on work. All movements are mixed, but some recent experiments may be quoted as indicating a division into three varieties of work, namely, positive, such as lifting a weight; negative, such as

lowering a weight; and static, such as maintaining a weight. The first two correspond to isotonic conditions of contraction, and the last to isometric contraction. As a measurement of the expenditure of energy in these forms of work a subject was given the task of lifting a weight on his hand, lowering the same weight and holding it steady both in the prone and supine positions, the rate of movement being controlled by a metronome:—

Form of work	Calories per sq. m. per hour
Positive	150·9
Negative	124·5
Positive and negative	180·5
Movements without weight	60·1
Static	94·6

In spite of the apparent severity of static work in producing fatigue the metabolism is not excessive, and the fatigue may be due to interference with the circulation.

Prof. A. V. Hill showed curves founded on the heat production of isolated frog's muscles, indicating that maintenance of a contraction is expensive, requiring ten times as much energy expenditure. He also gave results obtained by moving a flywheel at different rates of speed. The rapid rates of movement waste energy because the change of form of muscle requires work to be done in overcoming the viscosity of muscle, whilst slower rate of movement allows a larger proportion of energy to appear as external work. It is important to find out the most efficient relation between the work to be done and the rate at which it should be carried out.

Prof. H. Briggs described the physical endurance tests used during the war. He showed curves relating the variation of energy expended with the work done. A normal load is one which can be continued indefinitely. It was found that well-trained men get assistance from breathing oxygen only when doing excessive work, whilst a man in poor condition is helped by breathing oxygen with smaller loads. Stamina is the ability to maintain work. It appears that habitual hard work may maintain a man's stamina to greater ages than is found in sedentary individuals.

Dr. J. S. Haldane quoted experiments on the circulatory side of work. These experiments were made on man, the lungs being used as an aerotonometer. With increasing severity of work the blood-flow increases exponentially, whilst the percentage of oxygen desaturation of the blood rises logarithmically, and the output per heart-beat remains almost uniform. Therefore, the pulse-rate varies with the blood-flow. In a few individuals in whom the percentage of oxygen utilisation is already high the output of the heart increases as well as the rate of beat. Acapnia decreases circulation-rate, and is thus unfavourable to work.

Prof. A. V. Hill reported some results on pulse conduction in relation to blood-pressure, using the hot-wire sphygmograph. The pulse conduction can be expressed by

$$3\cdot57/\sqrt{\frac{\text{per cent. increase of arterial volume}}{\text{per mm. Hg increase in pressure.}}}$$

By measuring systolic and diastolic pressures and the rate of pulse conduction it is possible to estimate the increase in volume of the arterial reservoir at each heart-beat.

Prof. A. D. Waller described the simplified method for the estimation of physiological cost of work done under various industrial conditions. He suggested that, instead of the various arbitrary terms such as sedentary, light, medium, and heavy work, one should use the energy expenditures of 100, 200, 300, and 400 kilogram metres respectively.

Prof. A. Krogh laid emphasis on the effect of diet on the respiratory quotient and on efficiency. For short experiments a diet containing plenty of carbohydrate is better for maintained exertion. He criticised Prof. Waller's technique, but said that it was probably satisfactory for the investigation of energy expenditure under working conditions in industry. Prof. Waller's methods were criticised by several others. Some criticisms were on technical points, such as the accuracy of dry meters, temperature and pressure measurements or the size of bag used in collecting the expired air, and some were on the results, namely, the low carbon dioxide output in his published work. As Prof. Briggs pointed out, there may be greater sources of error neglected by both sets of workers than those due to the errors of analysis.

The discussion terminated by a paper on "The Economy of Human Effort in Industry" by Mr. E. Farmer. The aim of his study was to find more rapid methods of carrying out industrial processes. One must see the effect on output without the stimulus of special pay. The principles to be used in devising new methods are to encourage smooth movements without marked change in direction and to avoid the intervention of discrimination. He gave examples of increased output in packing chocolates and in metal polishing. Further points requiring study are: What is monotony, what is the influence of noise, and what is the influence of vibration on the workers?

A few individual papers were given.

Prof. A. Krogh described a simple apparatus, consisting of a volume recorder containing soda lime, for measuring oxygen consumption. The soda lime absorbs all carbon dioxide and the volume decrease as recorded on a kymograph gives a measure of the oxygen absorption.

Dr. J. C. Drummond gave an interesting account of some recent work in connection with vitamins and their relation to public health. Green plants and fruits are the main source of vitamins. Dairy products are good in furnishing the vitamins provided that the cows have been fed on green food containing them. The plankton in the sea by the presence of green plants is a source of vitamins which we obtain in fish and fish-oils. It is important that industrial populations should obtain a proper supply of vitamins, because a relative deficiency in them may cause ill-health without the appearance of such diseases as scurvy or beri-beri.

Dr. F. W. Edridge-Green reported experiments on mixing white light with spectral colours. He was followed by Dr. Shaxby, who described a useful instrument consisting of a grating spectroscope with two collimators by which the spectra are formed in reversed order. By a shutter in the eye-piece it is possible to compare monochromatic patches in reversed order.

Dr. R. J. S. McDowall read a paper on "The Independence of the Pulmonary Circulation as shown by the Action of Pituitary Extract." Tracings were shown in which the pulmonary pressure was seen to vary independently of the systemic circulation.

Dr. E. P. Poulton and Dr. W. W. Payne read a paper on "Epigastric Pain." They consider that epigastric pain is not necessarily referred pain, but that it may be due to spasmodic contractions of the œsophagus, stomach, or duodenum.

A number of demonstrations were given, and one

afternoon was spent seeing some of these at the Clinical Laboratory, Royal Infirmary. Amongst these demonstrations were Dr. R. K. S. Lim, demonstration of the mucoid cells of the stomach; Dr. E. P. Poulton and Dr. W. W. Payne, peristalsis of the human œsophagus; Mr. McClure, psychogalvanic reflex; and Prof. J. Meakins, respiration with decreased volume per respiration, with and without oxygen, and effect of resistance to breathing on respiration at rest and whilst working.

The Week in West Africa

AT a meeting of the Royal Anthropological Institute held on December 13 Mr. Northcote W. Thomas read a paper on "The Week in West Africa." He said there were in West Africa a number of sub-divisions of the lunar month, such as 16-day periods, 10-day periods, and the like, the origin of which was either in the market or in some religious belief. There were, in addition, a number of shorter units, comparable to our week, of more uncertain origin; they ranged in length from two to eight days. They were very rarely sub-divisions of the month, and there was reason, where the week is synchronised with the month, to suspect foreign influence. Generally speaking, the month in West Africa was of small importance and played no part in economic or religious life; it was reckoned from the day on which the new moon was first seen, but the native can only very rarely say of how many days it consists. There was no less uncertainty as to the length of the year; few, if any, tribes had any exact knowledge of its length. The calendar was sometimes adjusted by the recognition of two years of different length, as in Benin, where the female year seems to have been about 340 days in length.

The week has been traced to a religious origin. Webster has regarded the "rest day" as its germ, but the rest day is an institution of agricultural people, and there are many such peoples in Africa who have no week. On the other hand, the distribution of the market is practically conterminous with that of the week, and it is probable that the calendar first came into existence as a means of indicating the market day. We have, however, little or no evidence to show why the different units were chosen. A certain number of day-names are derived from names of deities, notably on the Gold Coast, but, generally speaking, the kind of work done on a given day or the market attended is the decisive factor, and consequently they are used only in a small area. To this there is one striking exception; the Ibo day-names, used also in a different order in Benin City, are found everywhere from the Niger to the Cross River, but we are ignorant of their meaning.

The four-day week of the Lower Niger, which appears to be independent of the week of the Congo, seems to occupy the largest area; but we know too little of the distribution of the five- and six-day weeks, especially in French territory, to make any very definite assertion. There is good reason to suppose that a non-Mohammedan seven-day week was known; some of these weeks are clearly expanded from an earlier four-day week, but they have native, not Arabic, names.

Scientific Research and Industrial Development.

IN a lecture on "The Benefits of Research to Corporations" (No. 18, R. and C. Series of Nat. Res. Council, U.S.A., 1921) Dr. Charles L. Reese, chemical director of the de Pont de Nemours Explosives Co., U.S.A., gives examples of the advantages which accrue when a large industrial concern is equipped with a staff capable of applying scientific knowledge to the improvement of materials and processes.

Before the war this important company had already systematised its procedure by developing a system of records and costing, and had completed a number of investigations which had been the means of saving money, resulting, for example, in methods for shortening the time of separation of nitroglycerine from its acids, increasing its yield, preventing its freezing in dynamites, and for nitrating cellulose by the use of the mechanical dipper. Studies from the company's laboratories on the nitration of toluene and of the characteristics of nitrocellulose propellants became of great importance when war broke out, as did also a process for the recovery of a considerable proportion of the alcohol used in gelatinising the propellant, this leading to a direct saving in corn—estimated at ten million bushels—which thus escaped being fermented.

During the war enormous extensions were made by the company for the production of nitrocellulose powder, trinitrotoluene, picric acid, amatol, and tetryl, and in this connection it is stated that the staff of the chemical and mechanical research departments of the firm was increased in number from 212 to 987, with an expenditure on experiment and research of 3,360,000 dollars for four years of the war, the output of military explosives being seven million tons.

Since the war the company has transferred its research organisation with success to the production of dyes, and is spending, and is prepared to spend, many millions of dollars on research to meet German competition, but protection is considered to be essential at present to the existence of the industry.

The address is interesting as giving an idea of the scope and the methods of a large chemical concern in utilising the services of scientific men for the investigation of new processes and the conservation of materials. A custom obtains with the company of recompensing inventors by means of a bonus in the form of the company's stock, in some cases sufficient to make them independent.

Little mention is made, however, of research on the theory of explosives, on which doubtless much work has been done by the staff. A few remarks may be made as to some subject-matter of the claims. Thus, while the mechanical dipper was undoubtedly an advance for obtaining output on the old pot-process of making nitrocellulose, the Thomson displacement process as used in this country and in France also greatly reduces handling of the material and eliminates fuming off, which appears still to occur occasionally with the mechanical dipper. Much is made of the "work found necessary to develop satisfactory methods for loading that very successful high explosive developed in England known as amatol, a mixture of trinitrotoluene and ammonium nitrate," but it is understood that an enormous

number of shell was filled with amatol by the methods supplied from this country. Again, tetryl, trinitrophenylmethylnitroamine, not "tetranitro-dimethylaniline," as stated, was not used exclusively in Germany before the war, but was made here also on the manufacturing scale.

The address, however, is of interest as showing a practical appreciation of the need for the application of scientific method in the development of old, and the acquisition of new, industries.

University and Educational Intelligence.

BIRMINGHAM.—The reports of the Council and of the Principal to be presented to the Court of Governors at the annual meeting on February 9 have been issued. The Principal appeals for more liberal provision of both undergraduate and post-graduate scholarships, and lays stress upon the difficulties which financial stringency imposes on the advancement of research. He reminds the Governors that "the war revealed the obvious, but often forgotten, truth that trained minds cannot be improvised, and that success in international competition will go to the nation which, by laborious and patient organisation, provides, through its universities, disciplined workers."

The extension of the University library is reported with satisfaction as a step in the direction of a more complete provision of that vital need of research workers. The overcrowding of the Mason College buildings is regarded as a grave menace to the continued expansion of the departments of medicine, biology, arts, and education. The obvious remedy is to transfer the biological departments to new buildings at Edgbaston, but as this would involve great expenditure of money the alternative of restricting entries to all the departments at present housed in Mason College may have to be faced in the near future.

The Principal appeals especially for more support from the districts surrounding the city, which send a large proportion of the students at present in the University, reminding them that "we cannot have it both ways: unrestricted admission of all the fully qualified and the withholding of a substantial contribution towards the financial cost of a university education."

Reference is made to the problem of adult education and the way in which the University is trying to do its share of this important work. "All who keep closely in touch with the main currents of educational opinion are impressed with the increasing insistence of the demand as well as with the complexity of the task involved in an 'educated democracy.' It would be disastrous if the handling of the problem became political; the provincial universities by sympathy and wise statesmanship, perhaps more than any other organisations, can avert this danger."

The Court of Governors is to be asked to confer the title of emeritus professor on Prof. J. H. Muirhead.

The assistance of the Birmingham Chamber of Commerce in completing the fund for a chair of Italian (which was started by Mr. Arthur Serena's gift of 5000*l*.) is gratefully acknowledged by the Council.

The appointment of Mr. Maurice Nicoll to the lectureship in psychotherapy, endowed by Sir Charles Hyde, is reported.

In commemoration of the work of Prof. P. F. Frankland, a fund has been subscribed for providing a Frankland medal and a prize of books to be given annually to the best student in practical chemistry.

A bequest of 2000*l*. under the will of the late Richard Peyton becomes available, by the death of his widow, "for the advancement of music."

Calendar of Industrial Pioneers.

January 26, 1891. Nicolas August Otto died.—Originally a commercial traveller, Otto began work on the gas engine in 1854. In 1867 with Langen he brought out the Langen and Otto atmospheric engine, and in 1876 he introduced the engine working on the Otto cycle, which proved to be the turning point in the history of gas motors.

January 27, 1848. Josiah Christopher Gamble died.—A pioneer among alkali manufacturers, Gamble was born in Ireland in 1776. He graduated at Glasgow University and became a Presbyterian minister. After a few years he abandoned the Church, started small works at Dublin for the manufacture of sulphuric acid, bleaching powder, and alum, and in 1828 with Muspratt founded the first chemical works at St. Helens.

January 27, 1885. Edward Davy died.—A contemporary of Wheatstone and Cooke, Davy invented an electric telegraph, experimented with a mile of wire in Regent's Park, and in 1837 at Exeter Hall exhibited his needle telegraph. In 1839 he sailed for Australia, where he became medical officer of health and Mayor of Malmesbury.

January 28, 1829. Thomas Tredgold died.—Known for his valuable writings on carpentry, the strength of materials, and the steam engine. Tredgold began life in the North of England as a journeyman carpenter. He studied mathematics, chemistry, and architecture, contributed to the "Encyclopædia Britannica" and the *Philosophical Magazine*, and made original investigations. He died in London at the age of forty, worn out by his labours.

January 28, 1864. Benoit Paule Emile Clapeyron died.—From the Ecole Polytechnique Clapeyron entered the mining service, taught in the School of Public Works at St. Petersburg, and on his return to France took part in the construction of some of the earliest French railways. He wrote on the mechanical theory of heat, and it was through his work that Kelvin was led to the study of Carnot's famous memoir. Clapeyron in 1858 succeeded Cauchy as a member of the Paris Academy of Sciences.

January 29, 1882. Alexander Lyman Holley died.—A graduate of the Brown University, Providence, Holley engaged in practical engineering, and in 1860 published an important work on American and European railway practice. He afterwards became a great ironmaster. The inscription on his monument in Washington Square, New York, states that he was "foremost among those whose genius and energy established in America and improved throughout the world the manufacture of Bessemer steel."

February 1, 1885. Stanislas Charles Henri Laurent Dupuy de Lôme died.—In 1848–52 Dupuy de Lôme built the *Napoléon*, the first steam line of battleship. About five years later he converted the finest two-decker in the French Navy, also called the *Napoléon*, into the *Gloire*, the first fully armoured sea-going ship ever seen. She was 256 ft. long, of 900 h.p., carried thirty-six guns, and was protected by 5 in. of iron and 26 in. of timber. Dupuy de Lôme was for some years Chief Constructor of the French Navy.

February 1, 1885. Sidney Gilchrist Thomas died.—A clerk in a London police court, Thomas studied chemistry and in 1870 attacked the problem of the dephosphorisation of pig-iron in the Bessemer converter. By 1875 he had solved the problem, and with the assistance of his cousin, Percy Gilchrist, and others, the commercial triumph of his important discovery was assured. His grave is in the Passy Cemetery in Paris.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, January 19.—Sir Charles Sherrington, president, in the chair.—L. **Hill**, H. M. **Vernon**, and D. H. **Ash**: The kata-thermometer—a measure of ventilation. The kata-thermometer is used in ventilation inquiries to estimate (1) the cooling, (2) the evaporative power of the air on a surface at body-temperature, and (3) as an anemometer to indicate the velocity of air-currents. Certain discrepancies having arisen, the "kata" formulæ have been re-investigated, using the large wind-channels at the National Physical Laboratory, and for low velocities the method of moving the "kata" through the air in a whirling arm, taking count of the effect of "swirl."—Lt.-Col. C. B. **Heald** and Major W. S. **Tucker**: Recoil curves as shown by the hot-wire microphone. The hot-wire microphone has been employed to measure body recoil as the result of heart action, and the records measure quantities proportional to the kinetic energy imparted to the body by motions of the blood. Thus slow-moving displacements, such as those of breathing, are not recorded. The apparatus can be standardised, giving the same responses from day to day for the same body recoils, and the kinetic energy of the body can be expressed in C.G.S. units. The results are consistent with physiological data.—E. W. A. **Walker**: Studies in bacterial variability: The occurrence and development of dys-, eu-, and hyper-agglutinable forms of certain bacteria. In the enteric and dysenteric groups of bacteria dys- and hyper-agglutinable forms occur. Both may be obtained from one eu-agglutinable strain of a bacillus. In agglutination tests a highly dys-agglutinable bacillus may fail to agglutinate with a serum that agglutinates the culture from which it was derived up to 1 in 1000. It may also fail to absorb from the serum the agglutinins specific to that culture. Noteworthy differences in behaviour thus exist between different individuals of a single culture. These facts may help to throw light on the problem of seriological strains.—Marjory **Stephenson** and Margaret **Whetham**: Studies in the fat metabolism of the timothy grass bacillus. During the growth of the timothy grass bacillus on a medium of inorganic salts, including ammonia as the sole source of nitrogen, glucose, and sodium acetate, the formation of protein, nitrogen, and fat was followed and correlated with the disappearance of glucose and acetate. No intermediate decomposition products of glucose were found. The growth of the organism on possible intermediate products of the breakdown of glucose was then studied. The growth on lactic acid was very similar to that on glucose alone. Growth on acetic acid was negligible. Growth on acetic and lactic acid showed that lactic acid enabled the organism to utilise the acetic acid. The acetic acid utilised in the presence of lactic acid or glucose served to increase the proportion of lipoid material formed, and not to increase the general growth of the organism. Growth on propionic and butyric acids was like that on lactic acid.—J. A. **Gardner** and F. W. **Fox**: The origin and destiny of cholesterol in the animal organism. Pt. 12: The excretion of sterols in man. Measurements of the intake and output of sterols in twenty-six cases on known diet show that in every case, except one, there was an excess of output over intake. The average daily negative balance was 0·3 gram, but individual balances were very variable. A considerable portion of the cholesterol of the food and of the bile is re-absorbed in the intestine along with the bile salts, but this process appears to be limited by the reduction of cholesterol to bi-hydrocholesterol in the intestine, a process especially characteristic of the adult human subject. The excess of output of cholesterol over intake leads to the conclusion that there is some organ in the body capable of synthesising cholesterol. The intake of unsaponifiable matter not precipitable by digitonin is much larger than the output.—S. J. **Lewis**: The ultra-violet absorption spectra and the optical rotation of the proteins of the blood sera. The absorption curve of pseudo-globulin is constant and the same for both the horse and human varieties. The curve for eu-globulin differs considerably from that for pseudo-globulin in extinction coefficients, but not in general form. The absorption curves for the horse and human varieties of albumin are similar, except for a constant ratio in their magnitudes, and this difference may be due to the association of an aggregate possessing little or no selective absorptive power, *e.g.* an aliphatic amino-acid or a polypeptide, with the principal aggregate. The close similarity in form of all the curves when corrected to a common amplitude, and the fact that the amplitudes are nearly all simple multiples of a common factor, point to similarity of constitution amongst these proteins and to a variable "concentration" of the active group. Processes for the separation and purification of the proteins have been elaborated.

Mineralogical Society, January 10.—Mr. A. Hutchinson, president, in the chair.—C. E. **Tilley**: Density, refractivity, and composition relations of some natural glasses. The glasses investigated fall into two groups, (*a*) tektite glasses and (*b*) volcanic glasses. The characteristics of the former confirm their divergence from volcanic glasses, and support the theory of their meteoritic origin. The specific refractivities of five analysed glasses are compared with the values calculated from the specific refractivities of their component oxides, and a notable correspondence is revealed. The influence of contained water on the specific refractivity is discussed and some figures bearing on the volume-change accompanying the passage from the vitreous to the crystalline state are given.—H. H. **Thomas** and E. G. **Radley**: The so-called "avanturine" from India, with an analysis of the contained mica. The stone is a quartz-schist, and owes its colour to plates of green fuchsite arranged parallel to the planes of foliation. The mica contains 1·77 per cent. Cr_2O_3 and a little vanadium; its optical characters are described. The probable source of the stone is discussed and the deterioration of the stone by heat and other causes is explained.—A. **Russell** and A. **Hutchinson**: Laurionite and paralaurionite from Cornwall. Laurionite associated with phosgenite and anglesite in a cavity in limonite is described in a specimen obtained from the collection of John Hawkins, of Trewithin, Cornwall. The locality is probably Wheal Rose, Sithney. Paralaurionite occurs with phosgenite in a very similar specimen in the collection of the late H. J. Brooke, said to come from Wheal Confidence, Newquay.—A. **Russell**: A discovery of pitchblende at Kingswood Mine, Buckfastleigh, North Devon. Pitchblende, occurring in a north and south lode associated with chloanthite, and native bismuth is described. The discovery shows promise of being of some economic importance.—W. A. **Richardson**: The distribution of oxides in Washington's collected analyses of igneous rocks. Frequency curves are given for all the oxides, and show considerable differences from those previously published. The silica curve is the most interesting, and shows two maxima, one at 52 per cent. and the other at 72 per cent. SiO_2. The frequency curve for SiO_2 can be matched by a combination of two normal curves or error with origins

on the 52 and 72 per cent. lines.—W. A. **Richardson**: A simplification of the Rosiwal method of micro-analysis. A method by which, using a drawing apparatus, the lengths of component minerals of a rock can be projected on to separate strips of paper and directly summed is described.—Dr. A. **Schoep**: The absence of cobalt in cornetite from Katanga, Belgian Congo. Microchemical tests made on carefully selected crystals from the original locality (Star of the Congo Mine) prove that cobalt is present only in associated black spots of heterogenite. The mineral is thus a hydrated phosphate of copper, agreeing completely with that recently described from Northern Rhodesia.

PARIS.

Academy of Sciences, January 9.—M. Emile Bertin in the chair.—C. **Lallemand**: The genesis and present state of the science of the abacus.—T. **Varopoulos**: A class of increasing functions.—P. **Humbert**: The product of Laplace relative to certain hypercylinders.—G. **Dumas**: A normal table relating to unilateral surfaces.—A. **Denjoy**: Functions defined by series of rational fractions.—B. **Gambier**: Surfaces and varieties of translation of Sophus Lie.—C. **Nordmann** and M. **Le Morvan**: Observation of an abnormal star by the heterochrome photometer of the Paris Observatory. The star 13 Cepheus presents some singular anomalies. It belongs to the spectral type A (hydrogen stars), but has a yellow coloration. The colour photometer shows that the light intensity is distributed in the spectrum in such a manner that the more refrangible rays are proportionally less intense than in any of the stars hitherto studied, not only of this type, but also of types F and G. It is possible that the atmosphere surrounding this star possesses exceptional absorbing power.—E. **de Martonne**: The massif of Poïana Ruska and the correlation of the erosion cycles of the southern Carpathians.—E. **Carvallo**: The principle of relativity in dielectrics.—P. **Chevenard**: The expansion of chromium and the chrome-nickel alloys over a wide temperature interval. A differential dilatometer was employed in which the standard bar was a nichrome (with 10 per cent. of chromium), the law of expansion of which had been carefully determined by direct methods. A diagram is given of the results on commercially pure chromium (98·3 per cent.) and five chrome-nickel alloys. The diagram gives the coefficients of expansions as functions of the temperature over the range 0° C. to 900° C.—M. **Faillebin**: A mixed organo-metallic compound of aluminium. Aluminium and methylene iodide in dry ether in the presence of a little iodine react in two ways, the principal reaction giving $CH_2{\cdot}AlI$ and AlI_3, the subsidiary reaction AlI_3 and ethylene.—J. **Barlot** and Mlle. M. T. **Brenet**: The determination of fatty acids by the formation of complex compounds with uranyl and sodium. Streng's reagent (acid solution of uranyl nitrate) is known to give a precipitate of a double salt with sodium acetate. Similar precipitates are obtained with the sodium salts of higher fatty acids, but only if the acid contains an even number of consecutive carbon atoms. Thus formates, propionates, *iso*butyrate, and normal valerates give no precipitate, but the reaction is obtained with acetic, normal butyric, fermentative valeric and normal caproic acids.—Y. **Milon** and L. **Dangeard**: A Redonian formation (Upper Miocene) forming ravines with the Eocene clays to the south of Rennes (Ille-et-Vilaine) containing iron minerals.—E. **Zaepffel**: The mechanism of the orientation of leaves. The movements of the leaf are connected with the distribution of water, and this distribution is influenced by the mobile starch.—C. **Douin**: The gametophyte of the Marchantiæ.—L. **Plantefol**: The toxicity of various nitrophenols for *Sterigmatocystis nigra*. Experiments were carried out with three isomeric nitrophenols, dinitrophenol, and trinitrophenol. All these proved more toxic to the mould than phenol itself. The three mononitrophenols differed in toxicity, the para-compounds being the most toxic. The dinitrophenol had the greatest effect in inhibiting the growth of the mould of any of the substances tried; it is nearly 300 times more toxic than phenol.—E. **Chatton**: Polymorphism and maturation of the spores of Syndinium.—R. **Sazerac** and C. **Levaditi**: The use of bismuth in the prophylaxy of syphilis. Sodium potassium tartarobismuthate, administered in intramuscular injection, acts preventively against syphilitic infection, and the same salt applied locally in the form of salve acts preventively even after infection. The conclusions were arrived at after experiments on rabbits.

Diary of Societies.

THURSDAY, JANUARY 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—S. Gordon: Sea Birds and Seals.

ROYAL SOCIETY, at 4.30.—W. B. Hardy and Ida Doubleday: Boundary Lubrication: The Paraffin Series.—Prof. W. A. Bone, A. R. Pearson, E. Sinkinson, and W. E. Stockings: Researches on the Chemistry of Coal. Part 2: The Resinic Constituents and Coking Propensities of Coals.—Dr. J. A. Crowther and B. J. Schonland: The Scattering of β-rays.—Ann C. Davies: The Minimum Electron Energies associated with the Excitation of the Spectra of Helium.—C. N. Hinshelwood, H. Hartley, and B. Topley: The Influence of Temperature on Two Alternative Modes of Decomposition of Formic Acid.—Prof. C. V. Raman: The Molecular Scattering of Light in Water and the Colour of the Sea.

ROYAL AERONAUTICAL SOCIETY (Students' Meeting) (at Royal Society of Arts), at 7.—C. Daniel: Practical Points in Fuselage Construction.

INSTITUTION OF LOCOMOTIVE ENGINEERS (London) (at Caxton Hall), at 7.15.—C. J. Allen: The Influence of Design on Express Locomotive Performance.

CONCRETE INSTITUTE, at 7.30.—E. B. Moullin: Capillary Canals in Concrete, and the Percolation of Water through Them.

ROYAL MICROSCOPICAL SOCIETY (Metallurgical Section), at 7.30.—H. Wrighton: Demonstration of Polishing Metal Specimens.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, JANUARY 27.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Prof. E. P. Stebbing and others: Discussion: The Importance of Scientific Research in Forestry and its Position in the Empire.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—A. L. Howard: The Timbers of India and Burma.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—T. H. Littlewood: The Diffusion of Solutions.—H. R. Nettleton: A Special Apparatus for the Measurement at Various Temperatures of the Thomson Effect in Metals.—J. J. Manley: A Defect in the Sprengel Pump: its Cause and the Remedy.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Hunterian Lecture: The Facial Characteristics of the Races native to India.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—L. M. Jockel: Fuels and the Boiler-house.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. S. M. Copeman, Dr. R. A. O'Brien, Dr. A. J. Eagleton, and A. T. Glenny: Experiences with the Schick Test, and Active Immunisation against Diphtheria.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Viscount Burnham: Journalism

SATURDAY, JANUARY 28.

ESSEX FIELD CLUB (in Physical Lecture Theatre, West Ham Municipal College), at 3.—C. Nicholson: The Rosy-Marbled Moth (*Erastria venustula*) in Britain (with special reference to Essex).—G. Morris: Some Neolithic Sites in the Valley of the Essex Cam.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. C. Macpherson: The Evolution of Organ Music (2).

MONDAY, JANUARY 30.

INSTITUTE OF ACTUARIES, at 5.—G. King: A Short Method of Constructing Select Mortality Tables: Further Developments.

ROYAL SOCIETY OF ARTS, at 8.—C. Ainsworth Mitchell: Inks (Cantor Lectures) (2).

MEDICAL SOCIETY OF LONDON, at 9.—Sir Leonard Rogers: Amœbic Liver Abscess: Its Pathology, Prevention, and Cure (Lettsomian Lectures) (1).

TUESDAY, JANUARY 31.

ROYAL HORTICULTURAL SOCIETY, at 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Variable Stars (1); Short Period Variables.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. H. Wrench: Our Old Village Churches and their Story.
ILLUMINATING ENGINEERING SOCIETY (Joint meeting with the Royal Aeronautical Society) (at Royal Society of Arts), at 8.—Lt.-Col. L. F. Blandy and others: Discussion: The Use of Light as an Aid to Aerial Navigation.

WEDNESDAY, FEBRUARY 1.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—C. E. N. Bromehead: Some Notes on the New 6-inch Geological Survey of London and the Influence of the Geology on the History of the Area.
ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—Major H. D. Gillies: Demonstration of Plastic Surgery.
INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Major J. Erskine-Murray: (*a*) The Determination of the Decrement of a Distant Sending Station; (*b*) Some New Methods of Radio-Navigation.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.
ROYAL SOCIETY OF ARTS, at 8.—A. Wilcock: Surface Printing by Rollers in the Cotton Industries: A Comparison with other Processes of Printing Patterns for Cretonnes, Dress Materials, Wallpapers, etc.
SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—J. L. Lizius and N. Evers: Studies in the Titration of Acids and Bases.—Dr. J. C. Drummond and A. F. Watson: The Sulphuric Acid Reaction for Liver Oils and its Significance.—W. Dickson and W. C. Easterbrook: The Quantitative Separation of Nitrobody Mixtures from Nitro-glycerine.

THURSDAY, FEBRUARY 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Napier Shaw: Droughts and Floods (1).
ROYAL SOCIETY, at 4.30.—*Probable Papers*.—C. Shearer: The Oxidation Processes of the Echinoderm Egg during Fertilisation.—J. Schmidt: The Breeding Places of the Eel.—J. Gray: The Mechanism of Ciliary Movement.—J. Gray: The Mechanism of Ciliary Movement. II. The Effect of Ions on the Cell Membrane.—J. S. Huxley and L. T. Hogben: Experiments on Amphibian Metamorphosis and Pigment Responses in Relation to Internal Secretions.
LINNEAN SOCIETY OF LONDON, at 5.—F. Johanssen: The Canadian Arctic Expedition.—Dr. J. C. Willis and U. Yule: Some Statistics of Evolution and Distribution in Plants and Animals, and their Significance.—Mrs. E. M. Reid: Note on Fossil Floras.
ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.—Discussion on the Treatment of Gastric Ulcer. Speakers: Sir William Hale-White, Sir William Willcox, Sir Berkeley Moynihan, and Mr. Sherren.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—L. J. Romero and J. B. Palmer: The Interconnection of A.C. Power Stations.
CHEMICAL SOCIETY, at 8.—E. J. Hartung: The Action of Light on Silver Bromide.—C. K. Ingold: The Structure of the Benzine Nucleus. Part I. Intra-nuclear Tautomerism.—C. K. Ingold: The Structure of the Benzine Nucleus. Part II. Synthetic Formation of the Bridged Modification of the Nucleus.—C. K. Ingold and H. A. Piggott: The Structure of the Benzine Nucleus. Part III. The Suppression of Intra-nuclear Change.

FRIDAY, FEBRUARY 3.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.
ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion on the Depth of Origin of Earthquakes. Prof. Love in chair. Speakers: Prof. Turner, Prof. Lamb, R. D. Oldham, Dr. H. Jeffreys, Prof. Knott, Dr. C. Davison, and Major Taylor.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. K. M. Walker: The Nature and Cause of Old Age Enlargement of the Prostate (Hunterian Lecture).
EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.—Prof. H. J. Fleure: Some Social Bearings of Race Study.
JUNIOR INSTITUTION OF ENGINEERS, at 8.—Major W. Gregson: Utilisation of Waste Heat from Internal Combustion Engines.
ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Discussion on the Uses and Limitations of N_2O and O_2 Anæsthesia. Speakers: Dr. A. L. Flemming and others.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Francis Younghusband: The Mount Everest Expedition.

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

THURSDAY, JANUARY 26.

UNIVERSITY COLLEGE, at 5.15.—B. S. Rowntree: Industrial Unrest.
KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (2).
GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy in Daily Use (3).
ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN, at 6.—Dr. W. K. Sibley: Alopecia and its Treatment (Chesterfield Lecture).

FRIDAY, JANUARY 27.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (2).
KING'S COLLEGE, at 5.30.—Dr. H. W. Williams: The Peoples of the Caucasus (2); at 6.—Prof. G. Young: Brazil.
TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at the Mary Ward Settlement, Tavistock Place), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (1).
GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy in Daily Use (4).

SATURDAY, JANUARY 28.

LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (2).
HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: The Life and Habits of Mason Bees.

MONDAY, JANUARY 30.

UNIVERSITY COLLEGE, at 5.—A. T. Walmisley: The Bridges over the River Thames at London.
KING'S COLLEGE, at 5.30.—Dr. J. Steppat: Recent Developments in German Education and Student Life.—Prof. L. L. Fortescue: Wireless Transmitting Valves (2).

WEDNESDAY, FEBRUARY 1.

HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (2).

THURSDAY, FEBRUARY 2.

KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (3).
ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN (Leicester Square, W.C.2), at 6.—Dr. J. L. Bunch: Drug Eruptions (Chesterfield Lecture).
CIVIC EDUCATION LEAGUE (at Leplay House, 65 Belgrave Road, S.W.1), at 8.15.—Miss Barbara Low: Psycho-analysis in relation to Civics.

FRIDAY, FEBRUARY 3.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (3).
UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (1).
KING'S COLLEGE, at 5.30.—Rev. Dr. F. A. P. Aveling: Matter, Mind, and Man.—Dr. H. W. Williams: The Peoples of the Caucasus (3).
TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at the Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (2).

SATURDAY, FEBRUARY 4.

SALTERS' HALL (St. Swithin's Lane, E.C.4), at 10.30 a.m.—Dr. M. O. Forster: The Relation between Pure and Applied Chemistry.
LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (3).
HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: The Folk-lore of Natural History.

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The Influenza Problem.

THE widespread recrudescence of influenza in this country, although on a less fatal scale and of a less virulent type than in the experience of 1918–19, is an unpleasant reminder of our present helplessness in respect of this disease. Many volumes have been written about it. The old Local Government Board issued two reports by Dr. Franklin Parsons, which summarised all we then knew of the epidemic of 1890, and did much to expand our knowledge; and we have now before us an even more portly tome of nearly 600 pages upon the subject, issued by the new Ministry of Health. This report contains valuable historic material, an admirable clinical study of the disease, and suggestive speculations on the statistical aspects of the problem presented by it. These forcibly impress us with the imperfections of statistics dealing with altogether imperfect material. But we cannot be said to have greater knowledge of the disease, from the point of view of preventive medicine, than when Dr. Parsons's reports were issued. This is no reflection on the Ministry of Health; for in every civilised country investigators have similarly drawn a blank so far as guidance for the prevention of the disease is concerned.

We know certain elementary facts which, if they could be universally applied in practice, would prevent influenza from spreading; for the disease is infectious, and it is practicable to lessen the public opportunities of infection by avoiding unnecessary assemblies of people. But how can we avoid infection in social and business life, in view of the early infectivity of the disease, the failure to recognise mild attacks, and the short incubation period, which multiplies centres of infection at a very rapid rate? We commonly fail to prevent the spread of ordinary catarrhs; and this is an index of our incapacity or inertia in relation to the more serious disease.

The mere enumeration of matters concerned with influenza on which we are still ignorant is an almost tedious task. Let us attempt it partially. We know that at uncertain intervals influenza marches, or rather flies, through the world, without any known reason. The epidemics in this country of 1803, 1833, 1837–8, and of 1889–92, are well known, but many occurred in previous centuries, and some have even asserted that the sweating sickness was a type of influenza. We know that when influenza becomes epidemic it tends to recur in secondary and tertiary waves, as in our recent experience. The present outbreak is the fourth since 1918. Dr. Brownlee has given interesting evidence pointing to an appearance of law in the intervals after which recurrences occur; and we may hope to hear more from him on this point, not only as regards this country but also for other countries, as to whether this law holds good internationally.

Knowledge of the natural history of these outbreaks may be expected eventually to give some clue to prevention, though this is not yet visible. But it is not known why influenza takes on a worldwide march at irregular intervals. We may assume that endemic influenzal infection of low virulence and infectivity, for some unknown reason, changes its biological characters, and that one or both of these characteristics may become enhanced; but why? Attempts to associate pandemics with special meteorological conditions have had little or no success; and we are little further advanced than when Sydenham appealed to the "epidemic constitution" of certain years.

As an alternative to the acquirement of enhanced biological properties by the contagion of influenza may be cited the evidence of importation of infection and the rapid spread of the disease from country to country; but this merely puts the practical difficulty further back. Why this exceptional spread from country to country, and why does not influenza prevail, like measles, every second year in a given urban community?

Further light would be more easily obtainable if we were certain that the Pfeiffer bacillus is the true causal agent of influenza; it is not dispossessed from this position, but the evidence of bacteriologists in recent outbreaks has not strengthened its position; and although bacteriologists have isolated the

bacillus from secretions of influenzal patients and grown it in separate culture, they have failed in the crucial test of inoculation in animals to reproduce influenza.

This brings us to our next difficulty. In the absence of a certain bacteriological test, a further obstacle is that there is no characteristic symptom in influenza, like the rash in scarlet fever, or the throat membrane in diphtheria. On the contrary, what is supposed to be influenza assumes several types. At present cases with gastric symptoms are common, with few or no respiratory complications in a proportion of cases. But are we certain that these two types are the same disease? There is much evidence that commonly there is mixed infection; and in the great epidemic of 1918–19, which destroyed more of mankind than the great war, much of the mortality was due to secondary (or primary) invasion of hæmolytic streptococci.

On such an apparently simple point as the immunity conferred by a single attack the evidence is discrepant. Although it did appear that many of those attacked in the summer epidemic of 1918 escaped attack in the terrible epidemic of the following winter, the evidence is not satisfactory. It appears clear that if immunity is conferred by an attack, the immunity is of short duration; and this brings out the further point that inoculation of a vaccine prepared from the Pfeiffer bacillus and the associated coccal organisms cannot be expected to do much good, except perhaps in diminishing the seriousness of pulmonary complications.

Nor have we any plausible explanation of the remarkable change in the age incidence of deaths from influenza. In the epidemic of 1889–92 some 60 to 70 per cent. of all the recorded deaths from influenza occurred among patients more than 55 years old; in the recent epidemic, fatal cases at these ages formed only some 12 per cent. of the total, while about 70 per cent. of the total deaths were of patients less than 35 years old. Does this imply that we have recently been concerned with a different infection, or what is the explanation?

It is noteworthy that coincidently with epidemic influenza, certain other diseases, like cerebro-spinal meningitis and encephalitis lethargica, have prevailed to an exceptional extent. This has been explained by Dr. Hamer and others as implying that we are, in fact, in the grip of a single infection assuming multiform manifestations. But the association was not evident in the 1889–92 epidemic; and it is equally open to us to assume—and there are good grounds for maintaining—that all these diseases, each specific in character, are favoured by the same "epidemic constitution"—or what is concealed under this designation—and that they are not identical diseases.

The preceding incomplete review of the chief of the unknown factors in influenza must necessarily be somewhat depressing. It is well, therefore, to look for a moment at other diseases which, like influenza, at irregular intervals and for unknown reasons, assume world-wide movements, invading mankind in many countries. Among these cholera, plague, and smallpox may be specially mentioned. Yet each of these is entirely controllable, and, so far as a large part of the world is concerned, has been controlled. Cholera is now kept within bounds and almost non-existent in every country with elementary sanitation. Plague is controllable to the extent to which infection by rats and their fleas is stopped: a practicable programme. In smallpox there is the important additional protection of vaccination, and against a population protected by this measure waves of smallpox infection break for ever impotently. The last-named illustration is significant from the point of view of influenza. Both infections are usually received by the respiratory tract. Against one vaccination affords protection, against the other results of inoculation have been more than dubious. The world is waiting for further light. How is influenza and how are respiratory infections in general to be prevented? This is the unconquered region of preventive medicine. It will doubtless be occupied eventually, but after how much delay and on what plan it would be rash to hazard a prophecy.

An Elusive Group of Marine Organisms.

The Free-living Unarmored Dinoflagellata. By C. A. Kofoid and Olive Swezy. (Memoirs of the University of California, Vol. 5.) Pp. viii + 562 + 12 plates. (Berkeley, California: University of California Press, 1921.)

THE University of California at Berkeley, Cal., supported no doubt by large revenues from the State, sets a noble example in publishing valuable contributions to knowledge. In addition to about thirty octavo series in zoology, physiology, and other sciences, the University Press issues large quarto Memoirs, of which the fifth volume is Kofoid and Swezy's "Dinoflagellata," a very notable work of 570 pages and twelve coloured plates. It is the result of observations made by Prof. Kofoid and his pupils over a series of years from 1901 onwards at the marine laboratories of the University of California and the more recently established Scripps Institution for Bio-

logical Research at La Jolla—both by work at sea off the coast of Southern California and by investigation of the beach sands.

The Dinoflagellata form an exceedingly important source of the food supply of the sea both in numbers and in the total mass produced. As synthetic producers of carbohydrates, proteids, and fats they hold high rank amongst microscopic marine organisms, and in abundance they are second only to the diatoms in the plankton, while locally and on occasions they may far outnumber them. These local massive developments are the all but universal cause of the discoloured seas and of the phenomena of luminescence. The present monograph deals with the least-known and most elusive members of the group, the naked or unarmoured forms.

One great difficulty in their investigation is the extreme delicacy of these organisms and their tendency to undergo cytolysis in even a few moments' exposure to light under the microscope. They are unfortunately most sensitive to the action of fixing re-agents, and almost instantaneous distortion and disruption prevent the preservation of permanent preparations. The investigator is therefore limited to rapid and immediate observation of the freshly captured living and usually very active organisms. It is only on a coast such as that of Southern California, where pure oceanic water with a rich pelagic fauna is brought within a few miles of a laboratory equipped like the Scripps Institution, that work such as that of Prof. Kofoid could be carried on. A specially devised net of the finest silk is towed for a very short time at a depth of 80 metres, the catch transferred to a relatively large volume of water, rushed ashore in a fast motor-boat (30 miles an hour), and divided up at once for the microscopes of half-a-dozen assistant observers, a surprising number of new and remarkable forms in exceptionally fine condition being revealed. Ordinary methods of plankton collection and preservation yield no traces of these extremely delicate organisms. This is an excellent example of new and refined methods at sea, such as can be adopted only in connection with a biological station, which are giving new results of great scientific interest. It must not be supposed, however, that all these Dinoflagellates are confined to oceanic water. Some are neritic, and species of Amphidinium, for example, have been found in vast numbers on damp beach sand at several localities in England, California, and elsewhere.

Many of these new unarmoured Dinoflagellates are brilliantly coloured, as the beautiful plates abundantly show, and some are wonderfully organised and specialised for such minute protozoa. Some possess, amongst other "organelles," a complicated ocellus or "eye," with lens, pigment mass, and sensory core, as well as a large mobile tentacle, and groups of nematocysts resembling those of Cœlenterata. The whole group and its subdivisions and the numerous genera, sub-genera, and species are discussed most fully from every point of view—general morphology and relations, minute structure, physiology, history, and distribution. In their nutrition the majority of marine unarmoured Dinoflagellates are holozoic, and even some of those that contain chromatophores and were hitherto supposed to be holophytic are now found to contain ingested foreign bodies in the cytoplasm. What is known of the life-cycles, including encystment, spore formation, binary and multiple fission, and possibly conjugation—and the effects of parasitism in some forms—are all discussed, but it is evident that much has still to be discovered in regard to these matters.

In regard to the evolution of the group, our authors show that it probably arose from the Cryptomonads, and the Dinoflagellata of to-day represent the terminal twigs of a phylogenetic branching. The attempt to find ciliate affinities through the remarkable genus Polykrikos is rejected as a misinterpretation. A new form, Protodinifer, is regarded as bridging the gap between the two main groups of Dinoflagellates, the Diniferidea and the Adiniferidea, but it may be pointed out that "Protodinifer" is clearly identical with the *Pelagorhynchus marinus* of Pavillard (*Comptes rendus*, January, 1917). Amongst notable changes in the more familiar classifications of the text-books are the removal of Noctiluca from the Cystoflagellata and its inclusion in the Gymnodinoidæ, and the abolition of the Pyrocystaceæ of Murray, Apstein, West, and others, as these latter organisms are now to be regarded as merely phases in the life-history of other Dinoflagellates.

In addition to the nematocysts in Nematodinium and Polykrikos and the ocellus in Pouchetia, etc., the most remarkable further specialisation is seen in the highly developed appendage or "prod," with protractile and retractile fibrillæ, which reaches its climax in the genus Erythropsis. The authors, in pointing out the cœlenterate resemblances of the nematocysts and the tentacle placed on the edge of the sulcus or mouth, and also the tendency to a multicellular condition seen in the "chains" of Ceratium and the two-, four-, or eight-celled "somatella" of Polykrikos, suggest that "pelagic Dinoflagellata may have given rise

to simple pelagic Cœlenterates in which cell boundaries and cell layers may have played only a secondary and belated part as the size of the organism increased."

The economic importance of these organisms is great, both as a food supply and also occasionally as a destructive agency. It is well known that they form a large percentage of the stomach contents of sardines and other small fish. At times they are the dominant forms of the plankton, and have been recorded by Kofoid as the cause of outbreaks of "red water" on the Californian coast and elsewhere which may be a menace to the health and life of slow-moving or bottom-living animals which, being unable to escape from the infested area, die in quantity and are cast up in masses on the shore. Such discoloration of the water, due to species of Gymnodinium and Gonyaulax, are recorded as extending sometimes (August, 1917) for a hundred miles or more along the coast.

To point out a few slips in such a splendid memoir may seem ungracious, but Prof. Kofoid would probably prefer to have friendly criticism: In the phylogenetic diagram on p. 84, have not Protodinifer and Oxyrrhis exchanged places, should not Protodinifer be Pelagorhynchus, and, near the top of the diagram, should not Nematopsis be Nematodinium? The text-figure on p. 509 is evidently printed upside down, and in Fig. F (p. 30) the numbers 2, 3, and 4 are misplaced. Some of the references to figures in the text are not correct, but the careful reader will notice these for himself and will readily discover what is intended.

So many species are described, redescribed, or discussed, and the synonymy and history are given so fully, that the memoir is truly a monograph of the group, and will be found indispensable by all who work at these important lower organisms.

W. A. HERDMAN.

The Theory of Probability.

A Treatise on Probability. By J. M. Keynes. Pp. xi + 466. (London: Macmillan and Co., Ltd., 1921.) 18*s*. net.

DR. KEYNES'S book is a searching analysis of the fundamental principles of the theory of probability and of the particular judgments involved in its application to concrete problems. He adopts the view that knowledge may be relevant to our rational belief of a proposition without amounting to complete proof or disproof of it, and treats the probability as a measure of this relevance. Otherwise he does not attempt to define "probability," regarding it as a concept intelligible without further definition. In this respect, as in several others, he is in agreement with the views expressed by Dr. Wrinch and the present reviewer (*Philosophical Magazine*, vol. 38, 1919, pp. 715–31), and some comparison of the two presentations may not be out of place.

Previous writers have practically all assumed that probabilities can be expressed by numbers, and this assumption was put into precise form in the paper mentioned. Dr. Keynes departs completely from tradition on this point. Defining an "argument" as the process of passing to knowledge about one proposition by contemplation of it in relation to another of which we have knowledge, he denies not only that the probabilities of all arguments can be expressed by numbers, but also that they can be arranged in a one-dimensional series at all. Thus the probability of one argument may be neither greater than, equal to, nor less than that of another. The difference in actual application between this theory and ours appears likely to be slight, for the definitions and hypotheses are such that practically any two probabilities that one needs to compare are comparable. From these the formal theory is soundly developed.

The principle of non-sufficient reason, or indifference, asserts that we assign equal probabilities to propositions if we have no reason to do the contrary. The author criticises severely many previous applications of this principle (so severely that an unprepared reader is likely to be betrayed into expecting him to reject the principle altogether). He finally modifies it by saying that neither of the propositions deemed equally probable may be expressible as the disjunction of two mutually inconsistent propositions, of the same form as itself, and both consistent with the data. His precise statement of this important principle makes it possible to evaluate a large class of probabilities that could otherwise be only estimated, and is a most useful advance.

Dr. Keynes rejects definitely the view of Jevons and others that if any two alternatives are exhaustive and mutually exclusive, and we have no reason to prefer one to the other, the probability of each is $\frac{1}{2}$. His reasons for believing that this view leads to contradictions, however, appear incorrect. He says on p. 43: "If, for instance, having no evidence relevant to the colour of this book, we could conclude that $\frac{1}{2}$ is the probability of 'This book is red,' we could conclude equally that the probability of each of the propositions, 'This book is black' and 'This book is blue,' is also $\frac{1}{2}$. So that we

are faced with the impossible case of *three* exclusive alternatives all as likely as not." It appears to us that each of these estimates is based on different evidence, and, therefore, that it is quite possible that the sum of the probabilities should be greater than unity. A person who could recognise only one colour, say, blue, all others appearing alike to him, would estimate the probability that the book is blue at $\frac{1}{2}$. A person who could recognise only red would make a similar estimate for red. But one who could distinguish red, blue, and black, and no others, would estimate each as having a probability of $\frac{1}{3}$. In each case we follow the author in assuming no previous knowledge of the proportions of different colours among books.

The point is worth insisting upon, for we believe that the author has for such reasons refrained from estimating prior probabilities in many cases where such estimates would have been useful. In his discussion of sampling inference, for instance, he refuses to admit that any plausible estimate of the probable composition of a sample can be made, however large a sample has already been examined, unless we have further evidence that no disturbing cause exists. Admittedly the inference depends on the prior probabilities of different compositions, but we have shown that in ordinary cases a wide range of variation of the prior probability produces little variation in the inference made with regard to the composition of a large sample, and we think this is the only justification required. The acquirement of knowledge about a disturbing cause provides additional data and is valuable for that reason; its absence is no reason for denying a probability inference not based on it.

The author's insistence on the desirability of careful testing of the sample to see whether different subclasses from it have compositions similar to the whole is, however, very important on other grounds, for his careful discussion indicates the precise usefulness of a kind of additional information that is often obtainable and valuable. His conclusion (p. 426) that "sensible investigators only employ the correlation coefficient to test or confirm conclusions at which they have arrived on other grounds" is an exaggerated statement, but perhaps a salutary one.

A form of the frequency definition is discussed and rejected on the ground that it does not give any basis for induction. According to this the probability of a proposition p on evidence q is to be obtained by selecting a large number n of instances of q. If m of these are also instances of p, the probability of p given q is defined to be m/n. This theory is taken too seriously; it would be sufficient objection to point out that, unless m/n is 0 or 1, the probability would necessarily be changed by having $n+1$ instances instead of n, and would therefore be conventional. In the form of the frequency theory discussed (and also rejected) in our paper the probability is defined as the *limit* of this ratio when n tends to infinity. This view, though it has been seriously advocated, is not mentioned by the author.

The faults attributed to the book above are all on the side of excessive caution, and the positive contributions are extremely valuable. It is clearly written, with a good index and a copious bibliography. The misprints are few. Whitehead and Russell's "Principia Mathematica" is, however, mentioned a few times as if it were by a single writer. The work should be read by every student of science who aims at a real understanding of his subject.

HAROLD JEFFREYS.

The Royal Society Catalogue.

Catalogue of Scientific Papers, Fourth Series (1884–1900). Compiled by the Royal Society of London. Vol. 17, *Marc–P*. Pp. v + 1053. (Cambridge: At the University Press, 1921.) 9*l*. net.

THE high standard set by the volumes already published in this series is fully maintained in the seventeenth volume of the Royal Society's "Catalogue of Scientific Papers." The work of preparing the material for the press and of proof-reading was carried out by Miss Vagner and Miss Barnard, and until December 1920 Miss Chapman was also engaged upon the work. The Cambridge University Press is to be congratulated on the typographical excellence of the volume, the small type which had to be used being quite easy to read.

The papers indexed are those published during the seventeen years 1884 to 1900 by authors whose names begin with the four letters M (from Marc onwards), N, O, and P. No less than 10,662 names are indexed, the number of separate papers being 57,474. Thus, on an average, each author has published one paper every three years. The volume brings up the total number of authors' names already printed for the period 1884–1900 to 49,750, and the total number of entries of papers published by authors whose names begin with letters from A to P inclusive to 279,902. The catalogue of papers by authors whose names begin with letters from Q to Z is still to be published.

The Committee say that the difficulties in the printing and publishing trade, which for a time delayed the regular delivery of proofs, have now been overcome, so that they look forward with

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confidence to an early completion of the remaining volumes. When these are published the gap between the "Catalogue of Scientific Papers" and the "International Catalogue of Scientific Literature" will be filled so far as the index of authors' names is concerned; the indexing of scientific papers under authors' names will then be complete up to 1914.

There will still remain the subject-index, of which we believe only the volumes for mathematics, mechanics, and physics have been published, and that some fourteen volumes have yet to appear. To most of us a subject-index is much more useful than an author-index. While an author-index is essential as a permanent record of work done by individual authors, it will be of little use to an investigator anxious to discover what has previously been done in a particular line of research. For such a purpose a subject-index is required. We therefore hope that the Royal Society will proceed with the production of subject-indexes for the period 1800–1900 on the plan already begun with such success.

In addition to the surname of the author, the "Catalogue of Scientific Papers" gives the full Christian names so far as these can be ascertained. This is not merely in order to give credit to those to whom it is due, but also to make it easy for those who refer to the catalogue to distinguish between an acknowledged master of a subject and a little-known author who may chance to have the same surname. We commend the printing of titles in the original language, followed, when necessary, by an English translation. Those who have attempted to render a foreign language into English know how difficult it is to convey the exact meaning of the author; it is better, therefore, to let him speak for himself. In some of our abstracting journals we may find titles of foreign papers not only translated but so altered that no one could reconstruct the original. Nevertheless we think the compilers of this volume would have done well to add the English equivalent of some of the titles which they have printed without a translation. This would apply, for example, to many papers published in Swedish.

The Royal Society, representing, as it does, all branches of science, is clearly the body best able to carry to a successful issue any work indexing the whole field of science; all who take an interest in science will therefore feel that they owe the Society a debt of gratitude for having undertaken the great work of making a complete catalogue of the scientific papers published during 1800–1900 and for showing its intention to continue the work to a successful issue. A monumental work of this kind will never be out of date, but will be treasured as a permanent record of the marvellous achievements in the domain of science during the nineteenth century.

Our Bookshelf.

Handbuch der biologischen Arbeitsmethoden. Edited by Prof. Dr. Emil Abderhalden. Abt. 5, *Methoden zum Studium der Funktionen der einzelnen Organe des tierischen Organismus.* (1) Teil 3, Heft 1, *Entwicklungsmechanik.* Pp. 218. 66 marks. (2) Teil 3, Heft 2, *Entwicklungsmechanik.* Pp. 219–440. 72 marks. Abt. 9, *Methoden zur Erforschung der Leistungen des tierischen Organismus.* (3) Teil 1, Heft 1, Lieferung 34, *Allgemeine Methoden.* Pp. 96. 30 marks. (Berlin und Wien: Urban und Schwarzenberg, 1921.)

(1) The five articles which form this "Heft" are concerned with the technique of experimental embryology. In his account of micro-surgery Prof. Spemann deals with the operations for the examination of eggs—for dividing them either incompletely, *e.g.* by means of a looped hair, or by actually cutting the egg into two—with transplantation of parts of embryos to unusual positions, etc. Prof. Barfurth discusses the technique for the inquiry into heteromorphosis and regeneration in various groups of animals—embryos as well as adults. In this part Fig. 48 is printed without reference letters or description. Prof. H. Przibram gives methods for investigating the influence on development of heat, light, gravity, etc.; Dr. Karl Herbst deals with the methods of modifying development by means of various salts in solution, and Dr. Neumayer describes the instruments and technique of a number of operations. The work forms a useful source of reference for research workers and advanced students who desire to ascertain the methods which have been most successful in practice.

(2) The memoir by Prof. Rhumbler deals with the methods of imitating or producing "models" of living processes by physical devices—*e.g.* amœboid movement, the ingestion of food as by an amœba, the formation of a test as in the Rhizopoda, cell-division, fertilisation, etc. The volume is a helpful and concise contribution to the literature of the physics of vital phenomena.

Both these parts would have been improved if they had been provided with an index or a table of contents.

(3) In this, the first article of a new volume, Prof. Przibram gives many useful suggestions as to the methodical beginning and carrying through of research in experimental zoology. The selection and clear statement of the problem to be attacked, the economical use of living specimens —and also of time—by carrying out, wherever possible, more than one line of research on the same

material, care in labelling all specimens—on these and other cognate matters the author draws from his extensive experience, and the article is one in which those who are beginning research will find much that is helpful.

Municipal Engineering. By H. Percy Boulnois. (Pitman's Technical Primers.) Pp. vii+103. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2*s*. 6*d*. net.

IT is clear from the matter in this little book that the author has had very extensive experience in municipal engineering, and the list of important appointments he has held—as noted on the title-page—gives ample confirmation of this impression. He is therefore usually a safe guide in the matter of offering advice to young men who intend to enter this profession. The position, appointment, and training of the municipal engineer are explained, and the special responsibilities he has to accept are fully discussed. A considerable number of examinations have to be passed; these provide, or should provide, evidence of a sound training in the scientific and other subjects required of the municipal engineer. It is, therefore, unfortunate that the author, whilst decrying "cramming," suggests on p. 44 that there are numerous coaches or crammers who can assist a candidate. We should rather have expected advice of a kind which would have led young men to spend a few years in following a course in engineering with special attention to municipal engineering. Such courses are now available at several colleges, and when combined with a pupilage for the sake of acquiring practical experience will produce properly qualified men. That the author fully understands this is clear from other pages in the book, and it is unfortunate that the blemish on p. 44 should appear in this otherwise excellent and helpful volume.

History of the Great War, based on Official Documents. By Direction of the Historical Section of the Committee of Imperial Defence: Naval Operations. By Sir J. S. Corbett. Vol. 2. Pp. xi+448+17 plans. (London: Longmans, Green, and Co., 1921.) 21*s*. net.

THIS volume, the second of Sir Julian Corbett's masterly series on the naval operations of the great war, covers the six months from November, 1914, to May, 1915. It is based primarily on the official documents of the British Admiralty, but the information supplied by these has been supplemented from other sources, notably the revelations of disillusioned German seamen, such as Admiral Scheer and Admiral Hugo von Pohl. The narrative is fascinating in its interest. It displays in their entirety the operations of which at the time of their happening we obtained but partial glimpses. Here we can read—and, if we once start, must continue to read—about the raid on Scarborough and Hartlepool (December, 1914), the loss of the *Formidable* (January, 1915), the early attacks on the Dardanelles (February, 1915), and the sinking of the *Lusitania* (May, 1915). The maps and plans are numerous and excellent.

A Sketch-map Geography: A Text-book of World and Regional Geography for the Middle and Upper School. By E. G. R. Taylor. Pp. viii+147. (London: Methuen and Co., Ltd., 1921.) 5*s*.

A SERIES of sketch-maps presenting the fundamental geographical facts of regions and places, with brief explanatory text. The author claims three advantages for this method. In his first claim, that pupils will acquire the habit of working out the geography of a place for themselves, instead of reading up the facts, we think that he is over-sanguine. Boys, at any rate, will just learn up his sketch-maps by heart as they formerly did the written facts. Probably, however (as he claims next), they will remember these facts better, and will find the diagrams more interesting than solid paragraphs. Also the third advantage may be realised—the pupils will become accustomed to illustrate their work with sketch-maps, and this is an excellent habit.

The book is in itself too "sketchy" for a youthful student. It is meant to be used in conjunction with a good atlas, but should also be supplemented by a more detailed text-book. It may then be a valuable aid to teachers.

Pneumatic Conveying. By E. G. Phillips. (Pitman's Technical Primers.) Pp. xii+108. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2*s*. 6*d*. net.

PNEUMATIC conveying is one of the so-called labour-saving devices, the usefulness of which has been recognised only comparatively recently. In the little book under notice Mr. Phillips sets forth the principles underlying the construction of pneumatic conveying systems and gives an account of some of the various uses to which this means of transport can be adapted. The first portion of the book deals with the different systems in use, and pumps, dischargers, pipe lines, suction nozzles, and other details of the necessary plant are described. Then follow chapters on grain and coal-handling plants and on the induction and the steam-jet conveyor. The concluding chapter recounts some of the multitudinous uses to which this extraordinarily adaptable and flexible method of transport can be put.

Small Single Phase Transformers. By Edgar T. Painton. (Pitman's Technical Primers.) Pp. x+95. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2*s*. 6*d*. net.

THE scope of this practical little volume is sufficiently indicated by the sub-title, "Explaining a Commercial Method of Design. Making Possible Economy of Material and Accurate Predetermination of Characteristics, and Giving Information Enabling the Amateur to Design and Construct a Transformer Meeting his own Requirements." The same attention does not appear to have been given hitherto to effecting economies in the design of very small transformers as to that of large apparatus, and the author's way of attacking the problem should prove of use in this respect.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Fossil Buttercups.

It is remarkable, as Prof. Cockerell points out in Nature of January 12, p. 42, that until his discovery of a Miocene buttercup no species of the family Ranunculaceæ should have been recorded among the fossil plants of North America. More especially is this the case because the carpels of Ranunculus are among the commonest fossils found in deposits of Pleistocene and Pliocene age in Britain and the neighbouring parts of the Continent. Among the many lists of fossils determined by my husband and myself from such deposits, in one only, the Pliocene of Bidart (Basses-Pyrénées), is the genus not represented, and in this deposit very few species of any kind were found.

The oldest carpel I have seen is that of an extinct batrachian Ranunculus (*R. gailensis*, E. M. Reid), very thick-walled and globose, from the base of the Pliocene of Pont-de-Gail (Cantal). From the same horizon, but another locality in Cantal, M. Pierre Marty recorded *R. atavorum*, Sap., which he considers nearly related to *R. fluitans*. It is quite probable, though it has not been proved, that carpel and leaf belong to the same species.

In the latest Pliocene of the Cromer Forest-bed, with the exception of two undetermined carpels, all are British species. In the Upper Pliocene of Tegelen (Holland) *R. aquatilis* and *R. repens* are found associated with *R. nodiflorus*, a species of Central Europe and the Orient, and with a single specimen of a peculiar form of *R. sceleratus* found more abundantly at Castle Eden. In the Middle Pliocene of Castle Eden no definite West European species is found, though the form of *R. sceleratus* already mentioned and a peculiar batrachian Ranunculus, both probably extinct, occur associated with two Central European species, *R. nodiflorus* and a varietal form (perhaps extinct) of *R. lateriflorus*, also an extinct species of which the affinity has not been discovered. In the Lower Pliocene of the Dutch-Prussian border the only West European species is *R. nemorosus*; it occurs associated with *R. nodiflorus*, *R. lateriflorus*, var., and the South European species *R. brutius*. In the lowest Pliocene of Pont-de-Gail one specifically indeterminable carpel and the batrachian *R. gailensis*, already referred to, were found.

Among the hundreds of Pleistocene and Pliocene specimens examined none has shown indications of two seeds, but I have not been able to carry the record of the genus so far back as Prof. Cockerell.

In the work here referred to the carpels were in every case obtained by "washing" the material and sieving away the matrix. Were this method applied to some of the North American Pleistocene and Tertiary deposits I should anticipate that they might yield, not only abundant carpels of Ranunculus, but the fruits and seeds of many other herbaceous plants.

Eleanor M. Reid.

Pinewood, Milford-on-Sea, January 23.

The Accuracy of Tide-predicting Machines.

In the article in Nature for November 24 last appearing under the title "British Research on Tides" there occurs a statement which may, perhaps, leave an erroneous impression with those not familiar with tide-predicting machines. The statement in question—"a test of the accuracy of the tide-predicting machines used by the Admiralty and the India Office has indicated some serious errors in their results, and it is concluded that the labour of reading the curves afforded by the machines, with any pretence to accuracy, is comparable with the labour of direct computation, while the value of the results is greater in the latter case"—although made definitely with reference to particular tide-predicting machines, might, nevertheless, leave the impression that tide-predicting machines in general were subject to "serious errors in their results." It therefore appears of value to discuss briefly the subject of the accuracy of tide-predicting machines and to refer to some tests made with a direct-reading type of tide predictor.

Tide-predicting machines, or tide predictors as they are frequently called, make use of the harmonic tidal constants, and are contrived for the purpose of summing a number of terms of the form $A \cos(at+\alpha)$, in which for each harmonic constant A is the amplitude, a the speed per unit time t, and α the initial phase. For any given port, therefore, the height of the tide at any time is the instantaneous sum of the simple constituent tides represented by the harmonic constants. And in the tide predictor this instantaneous summation is effected by means of a flexible chain which passes alternately over and under a series of pulleys the motion of each of which represents the changes in elevation of a particular simple tide.

The accuracy of a tide predictor is therefore to be measured by the accuracy with which it sums the simple constituent tides represented by the harmonic constants. It is necessary to emphasise this, for not infrequently one meets with the assumption that the accuracy of the tidal predictions tests the accuracy of the tide predictor. Tidal predictions are the product of the tide predictor, and for any given port aim to give in advance the times and heights of high and low water. And the test of the accuracy of these tidal predictions is, obviously, the closeness of agreement with the tides as they actually occur.

It is to be noted, however, that the times and heights of the normal or predictable tide are subject to the disturbing effects of variations in wind, atmospheric pressure, rainfall, and seiche. Hence, altogether apart from any imperfections in the tide predictor or in the harmonic analysis which separates out the simple constituent tides, tidal predictions may differ from the observed times and heights of the tide, due to the disturbing effects just mentioned, the times of occurrence of which cannot be foreseen at the time the tidal predictions are made. It is, therefore, obvious that, while in a measure the accuracy of the tidal predictions tests all the processes entering into their making, it does not strictly test the accuracy of the tide predictor.

Tide predictors are of two types, which we may denominate respectively as curve-tracing machines and direct-reading machines. In the former there is traced, to a suitable scale on a sheet of paper, a curve of the predicted tide from which the height of the tide at any given time or the times and heights of high and low water may be scaled. In the direct-reading tide predictor the height of the tide at any time, and also the times and heights of high and low water, are indicated on dials from which they are read off directly.

It is obvious that the prediction of tides can be carried out more rapidly with a direct-reading tide predictor than with the curve-tracing type, for reading figures from two or three dials is less time-consuming than scaling these same values from a curve. But

even apart from its greater economy in time, the direct-reading machine has a still further advantage in that it is possible to secure more accurate results than with the use of the curve-tracing type. The dials on the direct-reading tide predictor are graduated to single minutes and to single tenths of a foot; it is, therefore, not difficult to estimate to within half a minute or five hundredths of a foot. To estimate as closely from a curve drawn to a moderate time-and-height scale is well-nigh impossible.

Since the tide predictor sums a number of continuous functions, it cannot be made to give the exact results of an adding or a multiplying machine. And because of the large number of moving parts that enter into the construction of a tide predictor, we cannot hope to secure the accuracy that may be obtained with a planimeter. In fact, the errors of the tide predictor may be ascribed almost wholly to the varying tensions on the numerous moving parts, but it appears that these errors should not be large enough to be serious.

In 1910 the U.S. Coast and Geodetic Survey put into operation a direct-reading tide predictor which had been constructed in its instrument division. Prior to the use of this machine for the prediction of tides for the annual tide tables it was carefully tested, one of the tests consisting in the comparison of the hourly heights of the tide as given by the machine and as computed analytically "by hand." The machine was set with 30 components for Hong Kong, China, January 1, 1912, and run through to December 31. For that day hourly heights of the tide were read off for the entire twenty-four hours.

At the beginning of this year, after it had been in use about twelve years, the machine was again set for Hong Kong, January 1, 1912, and run through to December 31, and the hourly heights read off. December 31 was chosen so that all errors due to the incommensurability of the speeds of the various components might accumulate. The table below shows the differences between the computed and the predicted heights:—

Hourly Heights of Tide, Hong Kong, China, December 31, 1912.

Hour	Predicted in 1910. Feet.	Predicted in 1922. Feet.	Computed. Feet.	Differences 1910. Feet.	Differences 1922. Feet.
0	4·28	4·30	4·32	−0·04	−0·02
1	4·65	4·67	4·68	−0·03	−0·01
2	4·78	4·78	4·80	−0·02	−0·02
3	4·60	4·61	4·59	+0·01	+0·02
4	4·07	4·08	4·05	+0·02	+0·03
5	3·27	3·27	3·22	+0·05	+0·05
6	2·32	2·32	2·28	+0·04	+0·04
7	1·42	1·42	1·37	+0·05	+0·05
8	0·70	0·70	0·66	+0·04	+0·04
9	0·31	0·31	0·27	+0·04	+0·04
10	0·34	0·33	0·33	+0·01	0·00
11	0·76	0·78	0·81	−0·05	−0·03
12	1·51	1·52	1·56	−0·05	−0·04
13	2·31	2·32	2·37	−0·06	−0·05
14	3·00	3·01	3·06	−0·06	−0·05
15	3·48	3·48	3·53	−0·05	−0·05
16	3·70	3·68	3·73	−0·03	−0·05
17	3·64	3·63	3·66	−0·02	−0·03
18	3·38	3·38	3·40	−0·02	−0·02
19	3·04	3·06	3·07	−0·03	−0·01
20	2·73	2·74	2·75	−0·02	−0·01
21	2·50	2·52	2·51	−0·01	+0·01
22	2·46	2·47	2·47	−0·01	0·00
23	2·64	2·66	2·67	−0·03	−0·01

It is to be noted that the height-scale on the tide predictor is graduated to tenths, so that the hundredths were estimated. The differences between the heights as predicted and as computed are relatively small, in no case exceeding 0·06 ft. It is also interesting to note the close agreement between the predictions made in 1910 and those in 1922, these predictions being made not only twelve years apart, but also by different persons. It is only proper to add that these predictions were undoubtedly carried out with more than ordinary care, owing to the psychological effect of the knowledge that a test was involved. Furthermore, it must be stated that with a single-component tide the accuracy attained was not so gratifying as in the example given above, the reason being that with a number of components there are compensating tensions of the moving parts, while with a single component there are no such compensations. It is to be borne in mind, however, that in the prediction of tides there is always a considerable number of components involved.

It would be unfortunate if the impression that tide predictors are subject to serious errors gained currency, for, apart from the use of such machines for the prediction of tides for the tide-tables, there are numerous tidal problems involving time-consuming computations which may be very easily made with the tide predictor. In the elimination of the effects of short-period tides on daily mean sea-level, in the computation of the changes in sea-level due to tides of long period, in the elimination from the observed tide of the tide due to a number of constituents, and in similar problems, the tide predictor should very materially lessen the laborious computations involved.

H. A. MARMER.

U.S. Coast and Geodetic Survey, Washington, D.C., January 5.

THE errors found in the British tide-predicting machines referred to in the article were more serious than those described by Mr. Marmer. The machines were of the curve-tracing type, and therefore inevitably less accurate (with the time and height scales ordinarily used) than direct-reading machines; they had zero errors, and also diminished the apparent range of the tide. The direct-reading machine used by Mr. Marmer is both more accurate and quicker in use; for many purposes, though perhaps not for all, such a machine is a valuable substitute for numerical computation.

THE WRITER OF THE ARTICLE.

The Oxidation of Ammonia.

THE following details of the early history of the oxidation of ammonia, a process which became of great importance during the war, do not appear generally to be known, and may be of interest. The first clear statement of the oxidation of ammonia which I have seen is contained in a paper by the Rev. Isaac Milner, B.D., F.R.S., president of Queens' College, Cambridge, published in the Philosophical Transactions for 1789 (vol. 79, pt. 2, pp. 300–13), and republished in Crell's *Annalen* (1795, pt. 1, pp. 550–62). The title of the English paper is "On the Production of Nitrous Acid and Nitrous Air," and the German paper is a translation, in which "nitrous acid" is rendered "Saltpetersäure" and "nitrous air" (*i.e.* nitric oxide, NO) "Saltpeterluft."

Milner remarks that, although the relation between nitrous acid and the volatile alkali was known, there was no known case in which the latter was used in the production of nitrous acid or nitrous gas. In

March, 1788, he tried the experiment of fitting a retort containing caustic volatile alkali to a gun-barrel filled with crushed pyrolusite (maganese dioxide), and heating the latter to redness, whilst the retort was also heated. Signs of nitrous acid and nitrous air soon made themselves manifest, and by continuing long enough nitrous gas was obtained. The experiment was repeated many times; its success depended on the nature of the pyrolusite, the temperature of the furnace, and the patience of the experimenter. Full details are given as to the best way of carrying out the experiment. It frequently happens that the ammonia passes over unchanged. Red lead was found, unexpectedly, not to be active, but green vitriol burnt white gave better results.

The changes are correctly explained by Milner as due to oxidation. With burnt alum he obtained the curious result of the evolution of a large amount of inflammable gas mixed with hepatic air (sulphuretted hydrogen) and sulphur, whilst sulphur remained in the gun-barrel. It is, therefore, not sufficient merely to bring the volatile alkali in contact with a substance containing dephlogisticated air, but another substance is also necessary which has a strong attraction for the combustible substance.

It is also noteworthy that Black in his "Lectures on Chemistry" (edited by John Robison, Edinburgh, 1803) states that "our newspapers inform us that the French chemists procured saltpetre for the Army by blowing alkaline gas, and even putrid steams, through red-hot substances which readily yield oxygen" (vol. 2, p. 245); and there is a statement that "Mr. Milner of Oxford (*sic*) published a paper in the 79th volume of the Philosophical Transactions . . . but he did not attempt to ascertain how much of the nitrous acid might be produced from a limited and known quantity of the volatile alkali" (vol. 2, p. 455). Black (*ibid.*) gives a clear explanation of the process; the ammonia "is a compound of hydrogen and azote, we need only suppose that part of it is totally decomposed and destroyed by the action of the oxygen contained in the manganese. Part of it, uniting with the hydrogen, forms water or watery vapour; and part, uniting with the azote, forms vapours of nitrous acid." I have not traced the reference to the "newspapers," but a footnote on the same page (455) reads: "*January*, 1796. There is a rumour that the French have manufactured saltpetre, during a part of the war, by obtaining nitrous acid from the vapours of volatile alkali, forced to pass through red hot manganese. Author."

Many strange names have of late been given to the process of ammonia oxidation; we have heard of the "Ostwald-Mittasch process" and others. The first use of platinum as a catalyst appears to be due to Kuhlmann, of Lille, in 1839.

J. R. PARTINGTON.

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A Specimen of Wrought-iron Currency from the Kisi Country, Sierra Leone Protectorate, West Africa.

A SPECIMEN of iron currency from the Kisi country was obtained by one of us (E. R. M.) while on service in West Africa in 1915 through the agency of his servant, Ali Badara, the son of a chief in the adjoining Momo-Fullah country; and a description of it may be of interest to readers of NATURE.

As this form of currency ceased to be used after the establishment of the British Protectorate in 1787, the age of the specimen may be estimated at not less than 130 years, and probably more.

The "coin" (Fig. 1) is of rough workmanship, and consists of a strip of roughly forged rectangular section, one half being twisted and the ends hammered out into thin blade-like projections, the broad end serving to prevent the "coin" slipping through the belt in which it is carried.

Analysis shows the metal to be wrought-iron of good quality, probably made by the direct process of reducing an oxide ore by carbon in presence of a basic slag containing much iron oxide to prevent carburisation of the iron, most of the slag then being

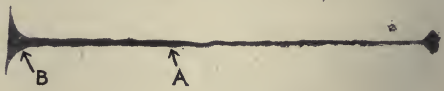

FIG. 1.—Photomicrograph × 1/5.

expressed by hammering the pasty mixture of iron and slag. The percentage composition is as follows: Carbon, 0·095; silicon, 0·103; manganese, nil; sulphur, 0·024; and phosphorus, 0·046. For the analysis drillings were taken from the wider part of the specimen and fragments from the narrow end. These were washed in benzene to remove the coating of black grease from the surface of the metal.

The metal is extremely soft and easily bent, the Brinell hardness at the point A being 121 (using a

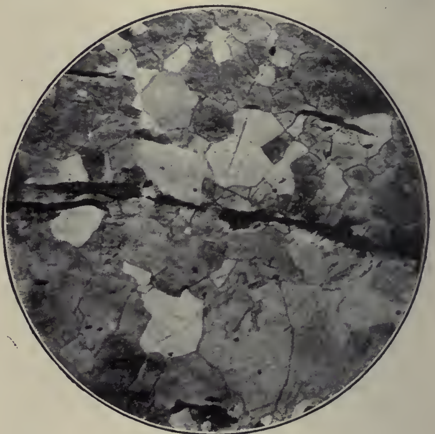

FIG. 2.—Photomicrograph × 275.

ball 1 mm. diameter and a load of 10 kilograms). A small fragment was cut from the point B, embedded in solder, polished, etched with 2 per cent. nitric acid in alcohol, and photomicrographed. The photomicrograph (Fig. 2) shows the typical crystalline structure of a pure iron, together with elongated inclusions of slag.

R. C. GALE.
E. R. MACPHERSON.

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Molecular Structure of Amorphous Solids.

A QUESTION of fundamental importance in the theory of the solid state is the nature of the arrangement of the ultimate particles in amorphous or vitreous bodies, of which glass is the most familiar example. Is it to be supposed that the molecules are packed

together at more or less uniform distances apart, as in crystals, the orientation of individual molecules or of groups of molecules being, however, arbitrary? Or, on the other hand, is the spacing of the molecules itself irregular, the solid exhibiting in a more or less *permanent form* local fluctuations of density similar to those that arise *transitorily* in liquids owing to the movement of the molecules? The physical properties of amorphous solids, notably their softening and viscous flow below the temperature of complete fusion, would tend to support the latter view, but the possibility of a closer approximation to the crystalline state should not entirely be ruled out, especially in view of the very interesting recent work of Lord Rayleigh on the feeble double refraction exhibited by fused silica (Proc. Roy. Soc., 1920, p. 284). A good deal might be expected to depend on the nature of the material, its mode of preparation, and heat treatment. A material formed by simple fusion and re-solidification of comparatively simple molecules, such as silicon dioxide, might stand on a different footing from a material such as ordinary glass built up by chemical action and formation of complex silicates.

If the arrangement of molecules in a vitreous body were irregular, the local fluctuations of optical density would result in a strong scattering of a beam of light passing through it, the intensity of such scattering being comparable with that occurring in the liquid state at the temperature of fusion of the material (see note by the present writer in NATURE of November 24 last, p. 402). On the other hand, if the arrangement of the molecules approximated to the crystalline state the scattering of light would be merely that due to the thermal movements of the molecules and would be much smaller. As a matter of fact, glasses exhibit a very strong scattering of light, some 300 to 500 times as strong as in dust-free air, the Tyndall cone being of a beautiful sky-blue colour and nearly, but not quite, completely polarised when viewed in a transverse direction. (Some glasses exhibit a green, yellow, or pink fluorescence when a beam of sunlight is focussed within them, and cannot be used for the present purpose; the fluorescence, even when very feeble, can be detected by the difference in colour of the two images of the Tyndall cone seen through a double-image prism.) Rayleigh, who observed the light-scattering in glass, attributed it to inclusions, some of which he assumed must be comparable in size with the wave-length (Proc. Roy. Soc., 1919, p. 476). The closest scrutiny through the microscope under powerful dark-ground illumination fails, however, to indicate the presence of any such inclusions, and it seems more reasonable to assume, in view of the foregoing remarks, that the scattering is really molecular. Its magnitude is of the order that might be expected on the basis of a non-uniform distribution of the molecules.

Further observations with specially prepared glasses and with fused silica would be of great interest to investigate the influence of the chemical constitution and heat treatment on the molecular *texture* of the solid.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta, December 29.

Forecasting Annual Rainfalls.

IN NATURE of September 1 last, p. 12, in commenting on the remarkable rainfall at Blue Hill Observatory, Mass., in July, 1921, departures from mean monthly amounts were given to show that the locality was experiencing a period of excess of rainfall. Furthermore, it was intimated that the annual amount for 1921 would exceed the 35-year normal by 150 mm. (5·90 in.). The excess actually was 136 mm. (5·35 in.) and practically a verification.

Many things must be considered in forecasting annual rainfalls, even after the year is well advanced, and no one appreciates the uncertainties better than the professional forecaster. All forecasting is hazardous, but weather forecasting is especially so.

Perhaps the most important factor in estimating the seasonal trend is the strength and location of the North Atlantic infrabar (the "centre of action" of Teisserenc de Bort).

In "The Winds of Boston" (Harvard College Observatory Annals, vol. 73, pt. 3, and vol. 83, pt. 1) the relation between surface-flow of the air and rainfall is given in some detail. A preponderance of east and south-east winds is evident during a rainy season.

The rainfall of 1921 supports the views there given. There was a marked deficiency of west-north-west wind and a marked excess of north-east to south-east wind. The average durations, 37-year normal, are: West, 1708 hours; north-west, 1543 hours; and north, 835 hours. In 1921 these values were decreased 14 per cent., 34 per cent., and 20 per cent. The excess of east wind is even more noticeable. Average durations are: East, 617 hours; south-east, 560 hours; and north-east, 838 hours. The deficiencies were: East, 57 per cent.; south-east, 47 per cent.; and east, 27 per cent.

A just estimate of the character of a season or of a year cannot be based absolutely on the quantity or duration of rain. One torrential rain lasting a few hours can offset weeks of rainless weather. At Blue Hill, fortunately, such occurrences are rare.

A striking illustration of the untrustworthiness of rainfall as a criterion of season is found in the recent flood in Texas. At Taylor, on September 9, 1921, following two months of drought, there was a rainfall of 587 mm. in twenty-four hours. This is the greatest daily rainfall yet reported in the United States following two months without any rain. This city had as much rain in one day as London gets in a year, yet the mean annual rainfalls of the two localities are not markedly different, being 620 mm. for London and about 970 mm. for the Texas city. Note that the latter locality received 60 per cent. of an annual rainfall in twenty-four hours. Such an accidental fall must be eliminated, or any effort to correlate pressure distribution, surface flow, and rain becomes futile. Furthermore, it would seem that efforts to link up variation in solar output and seasonal conditions as determined by the amount of rain are open to question.

ALEXANDER MCADIE.

Harvard University, Blue Hill Observatory, Readville, Mass., January 7.

Units in Aeronautics.

THE present writer's original letter was phrased with scrupulous care to limit consideration to the single proposition that consistency cannot be maintained in dynamical equations if gravity units are used in expressing inertia forces, in particular not by merging explicit g in the slug. An example was given so conclusive as to elicit, it was hoped, Prof. Bairstow's own explanation of the statement cited from his text-book.

No opinion was then offered on the validity of the relation $R = k\rho SV^2$, or on the merits of the poundal and dyne. The courtesy of this column would scarcely stretch to the detailed statement of the writer's position in respect of opinions attributed to him by implication on these and other apparently digressive points raised by Mr. Rowell and Sir George Greenhill.

A. R. LOW.

Some Problems of Long-distance Radio-telegraphy.[1]

By DR. J. A. FLEMING, F.R.S.

I.

THE achievement of transatlantic radio-telegraphy in 1901 and 1902 was of interest to physicists chiefly by reason of the fact that they did not see clearly why it should have been possible at all. The mystery of it was increased when at later dates radio signals were transmitted a quarter of the way round the world, and finally, with high-power stations and thermionic valves detected even at the Antipodes.

The wave-length of the waves used in the earliest work at Poldhu was about 3000 ft. The earth, roughly speaking, is a sphere 42 million feet in diameter. Hence the ratio of wave-length then used to earth diameter was about 1 : 14,000.

In the case of light there is a small bending or diffraction of the wave round an opaque obstacle. In other words, there is some small amount of illumination within the boundary of the geometrical shadow. The average wave-length of light waves is about 1/2000th of a millimetre, and a sphere having a diameter of 7 mm. would be 14,000 of such wave-lengths. Now if an exceedingly small source of light were placed on the pole of a sphere 7 mm. in diameter in a dark region, it is certain that there would be no illumination at the equator of the sphere. In other words, there would not be any sensible diffraction at an angular distance of 90°. Modern long-distance radio-telegraphy conducted with waves of wave-length approximating to 10 miles or so can communicate even with the Antipodes.

The mathematical treatment of the problem of the diffraction round a conducting sphere of electric waves which are radiated from a transmitter at its pole consists in expressing the magnetic and electric forces at any angular distance θ in the form of a series of harmonic terms. It is in the summation of this series to obtain the integral effect at the receiver that the chief difficulties and differences of opinion occur, and most analysts have employed only an approximation. In 1918 Prof. G. N. Watson effected a new and complete summation which enables the value of the forces to be calculated for any point on an imperfectly conducting sphere.

The result of eighteen years' work on this problem by mathematicians of the highest rank has been to give us a formula for the current in a receiving aerial of given resistance determined in terms of wave-length, aerial heights, and distance which represents the result of pure diffraction acting round a spherical earth of perfect conductivity. On the other hand, when we come to compare the results of this diffraction formula with actual observations in practice we find an enormous discrepancy. The actual received currents in the case of long-distance stations for the usual sending aerial currents are hundreds of thousands, or even millions, of times greater than the received current predicted by the theoretical formula. Thus, to take a case quoted by Dr. Van der Pol from observations made at Darien Radio Station, on the Panama Canal, on radio signals sent from Nauen, near Berlin, Dr. L. W. Austin gives the following figures: $I_1=150$ amperes, $\lambda=9\cdot4$ km., $a_1h_1=120$ metres, $a_2h_2=146$ metres, $R_2=29$ ohms, and $d=9400$ km. Now the actual received current was $I_2=1\cdot3$ microamperes, but the value predetermined by the formula is only 0·6 of one millionth of a microampere. In other words, the actual received current in this case is two million times greater than the predicted current.

The upshot of the whole matter then is this: Long-distance radio-telegraphy, say, round one-quarter of the circumference of the earth, would certainly be quite impossible but for some cause, other than diffraction, operating to compel the waves to follow round the earth's curvature and not quickly glide off it.

Oliver Heaviside in 1900 suggested that an upper conductive layer on the atmosphere might act as a guide to the waves, radio-telegraphy being, in fact, conducted in a thin spherical shell of non-conductive air bounded by a conductive earth and a conductive upper air. He did not furnish any valid reasons to explain why this upper air conducts and how its conductivity is preserved, and although the suggestion has been very generally accepted by radio engineers, it has been taken without sufficient criticism of its difficulties and details. There has been in the intervening twenty-one years an immense accumulation of facts, all showing, however, that long-distance radio-telegraphy is conditioned by the physical constitution of our atmosphere and is very far removed indeed from being simple electromagnetic wave propagation in empty space. An important epoch in this connection is the year 1902, when Senatore Marconi discovered during one of his early voyages across the Atlantic in the s.s. *Philadelphia* in February, 1902, that radio signals from Poldhu could be received at night about thrice the distance they could be read in daytime, being detectable only up to 700 miles by day, but readable up to 2099 miles by night.

It was at once surmised that the difference was due to ionisation of the air by sunlight, which, by liberating electrons from atoms, gives to the air conductivity. It was some years before this vague suggestion was converted by Dr. W. H. Eccles into a more definite scientific theory, many speculations in the meantime being found wanting in adequate basis, such as that which regarded the sunlit air as having an absorption for the energy of electromagnetic waves similar to that of foggy or misty air for visible light.

[1] Abridged from two sections of the Trueman Wood lecture on "The Coming of Age of Long-distance Radio-telegraphy and Some of its Scientific Problems," delivered before the Royal Society of Arts on November 23, 1921. The complete lecture is published in the Journal of the Society for December 9 and 16, 1921.

Before entering into further discussions of the facts, it will be convenient to mention a few of the generally accepted views as to the constitution of the terrestrial atmosphere and its ionisation by light.

By the use of hydrogen-filled sounding balloons carrying self-recording meteorographs, it has been possible to explore the atmosphere up to a height of about twenty miles. One of the results is to show that our atmosphere may roughly be divided into two regions. In the lower layer, called the *troposphere*, the atmospheric gases are kept well mixed up by winds and convection. This layer extends to a height of six or seven miles or so, and in it the temperature falls regularly with increasing height at the rate of about 6° C. per kilometre of ascent until a temperature of about $-55°$ C. is reached. Above this is a zone called the *stratosphere*, of unknown thickness, in which the temperature remains constant. Above a height of about seven miles water vapour is absent, and at higher levels convection ceases to operate and the atmospheric gases arrange themselves in order of density. The outer and highest levels above a height of sixty miles (=100 km.) are chiefly composed of helium and hydrogen with possibly some small admixture of the rarer atmospheric gases neon and krypton.

The volume composition of the atmosphere at the earth's surface is as follows:—

Nitrogen ...	78·05 per cent.
Oxygen ...	21·00 ,,
Argon ...	0·93 ,,
Carbon dioxide	0·03 ,,
Hydrogen ...	1 to 10 vols. in a million of air.
Neon... ...	10 ,, ,,
Helium ...	1 to 2 ,, ,,
Krypton ...	1 vol. ,, ,,
Xenon ...	0·05 ,, ,, ,,

Oxygen is almost entirely absent at a height of 100 km., but nitrogen is still present in a rarefied form. The presence of hydrogen and helium at these high levels has been indicated by an observation of Pickering on the spectrum of a meteoric stone entering the earth's atmosphere, which showed the hydrogen and helium lines.

Next, as regards the action of light on the gases of the atmosphere. Light waves of high refrangibility impinging on nearly all substances, especially those containing electropositive atoms, liberate from them electrons. The atom is now considered to be a collocation of negative electrons arranged in concentric shells, possibly in orbital motion, round a central positively charged nucleus in which the gravitative mass of the atom chiefly resides. Light of short wave-length causes one or more of these negative electrons to be detached and projected with a high velocity. The more electronegative an atom is the higher must be the frequency of the light to affect it. The electrons so detached are called photo-electrons and the action photo-electric.

In the case of sodium or potassium, which are highly electropositive metals, photo-electrons are emitted under the action of visible light, about the middle of the spectrum, but for less electropositive metals—*e.g.* zinc and magnesium—the action takes place only with ultra-violet light. Hence it follows that a plate of zinc illuminated by light from an electric arc or by the spark between aluminium balls loses a negative charge readily, and if insulated, becomes positively electrified owing to the loss of negative photo-electrons. The velocity with which these photo-electrons are projected is considerable, and may be 500–1000 km. per sec.

For most metals the ionising potential is about two to four volts, hence the maximum wave-length of ionising light is just beyond the violet end of the visible spectrum. But for atmospheric gases, when pure and free from dust or moisture, the ionising potential is much higher, being approximately as follows:—

Nitrogen ...	7·5 volts	Argon ...	12 volts
Oxygen ...	9 ,,	Neon ...	16 ,,
Hydrogen ...	11 ,,	Helium ...	20·5 ,,

It follows from this that the atmospheric gases cannot be ionised by light of longer wave-length than 1350 Å.U. Rays of this short wave-length are not transmitted by quartz but only by certain samples of fluorite, and are absorbed by a very small thickness of air. No sunlight of shorter wave-length than about 2950 Å.U. reaches the earth's surface, as shown long ago by Huggins and Cornu.

Hence the conclusion is forced on us that pure dust-free atmospheric gases cannot be ionised at the lower levels of the atmosphere by the direct action of sunlight, but at the higher levels above 60 to 100 km. doubtless there is direct ionisation.

Nevertheless, ionisation does take place in the lower atmospheric levels, as shown by the small finite electric conductivity possessed by the air, which proves that there are negative ions, either free electrons, or electrons attached to neutral atoms, and also positive ions present in the air, even over wide oceans. Thus, Boltzmann found in tests made in mid-Atlantic 1150 positive and 800 negative ions per c.c. of air. A. S. Eve found 600 to 1400 positive and 500 to 1000 negative ions per c.c., the positive being slightly in excess.

This ionisation may be produced either by photo-electric action on dust or ice particles in the air, by radio-active matter in the soil, by photo-electric action upon complex gaseous molecules in the air, or generated by the light and called condensation nuclei. Such agencies, however, cannot account for the far larger and permanent ionisation necessary to give the required electric conductivity in the higher atmosphere if it is to act as a guide to long electromagnetic waves.

A consideration of the terrestrial radio-telegraph problem shows that if there is any conductive layer in the upper atmosphere which can act as a guide to long electromagnetic waves round the earth, it must possess the following properties:—

(1) It must be permanently ionised, which means that its ionisation must not vanish in the night-time since, so far as we know, its guiding powers are not suspended on the shadow side of the earth. This seems to imply that the ionisation must be predominantly of one sign or that the *plus* and

minus ions are so far separated that they do not readily recombine. True gaseous photo-ionisation always produces ions of both signs in equal number mixed up together, and the conductivity quickly disappears when the ionising agency is withdrawn.

(2) The resulting electric conductivity must be sufficiently high, say, as good as that of ordinary fresh water, to act as a true wave guide. This implies that the ions must be very numerous per c.c. and very mobile or have high ionic velocities under unit electric force.

Bearing in mind that the upper regions of the earth's atmosphere above the 100 km. level probably consist chiefly of hydrogen, and that the velocity of ions in hydrogen under unit electric force is, according to measurements, from two to three times that in oxygen or nitrogen at the same pressure, it is easily seen that in the upper hydrogen levels of the atmosphere a very moderate amount of ionisation, say, 10^7 ions per c.c., might give a conductivity of the order of that of fresh water, or about 700,000 ohms per c.c. Another quality this conducting layer must possess if it is to act as a true reflector of long waves is a somewhat sharply defined lower surface.

It has already been remarked that observations on signal strength over long distances show an enormous difference between the actual measured values and those predicted by a simple diffraction formula. Attempts have been made to find an empirical formula for the received current in terms of the other quantities involved. At first these efforts started with the erroneous assumption that the attenuation might be regarded as due to an "absorption" caused by the atmosphere, and therefore mathematically represented by an exponential factor appended to the simple Hertzian expression for the magnetic or electric force at a known distance on the equatorial plane of a small oscillator.

Prof. G. N. Watson finds that if in place of a perfectly conducting spherical earth in free space we assume an earth having a conductivity about the same as sea water, enclosed in a spherical sheath or shell of material having a conductivity of about $1{\cdot}44 \times 10^{-15}$ E.M.U., equal to a specific resistance of 700,000 ohms per c.c. or not far from that of ordinary fresh water, the interspace being about 100 km., then the diffraction formula for the receiving aerial current would have to be modified and the exponential factor becomes $\epsilon^{-9{\cdot}6\theta/\sqrt{\lambda}}$. Watson therefore considers that if we are able to assume an upper conducting layer in the atmosphere at a height of about 100 km. having a fairly sharp under-surface and a specific resistance of about 700,000 ohms or, say, 0·75 megohm per c.c., then guided wave propagation through the included spherical shell of insulating air would account for the observed attenuation in actual terrestrial long-distance radio-telegraphy.

We have then to consider what are the probabilities and possibilities for the existence at a height of 100 km. or so of such a conducting layer and how it may be supposed to become ionised. Gaseous conductivity is always and only due to the presence of ions, and in the above case these are created by the strong electromotive forces brought into play. In gases contained in glass vessels there are always some few free ions or electrons present for some reason. If a high frequency magnetic field is made to act on the gas these ions are driven with great force against the gas molecules and ionise them, thus producing very quickly a copious supply of ions and giving the gas high conductivity. We cannot, however, say that a rarefied gas is a good conductor *per se* for very feeble impressed electromotive forces as we can say that a metal is a good conductor. Hence mere rarefaction due to height will not bestow the required electric conductivity on the atmosphere. Neither can the required ionisation be produced by solar light, because then it would vanish in the night-time by recombination of the ions.

The suggestion I wish to make as to the cause of this ionisation is based upon a modification of hypotheses already advanced by S. Arrhenius, K. Birkeland, and W. J. Humphreys concerning the projection of dust by light pressure from the sun.

We know that the sun's photosphere is in a continual state of disturbance due no doubt to violent explosions in regions beneath this light-giving locality. Above this photosphere lies the so-called reversing layer composed of metallic vapours which produce the Fraunhofer lines in the spectrum. These eruptions carry up not only metallic vapours, but also vast masses of the superlying chromosphere composed chiefly of hydrogen and helium gases in the form of solar prominences or red flames which are often seen rising to a height of several hundred thousand kilometres in a few minutes, thus indicating velocities of several hundred kilometres per second. When these solar metallic vapours are thus carried up into colder regions they must be condensed into a metallic mist or rain composed of particles of various sizes. We know also from experiment as well as theory that light exercises a pressure on solid objects and that this pressure per square centimetre for totally absorbing or black bodies is numerically equal to the light energy in the cubic centimetre. Measurements made of the so-called solar constant at the earth's surface when corrected for atmospheric absorption give a value of 2·5 gram calories per sq. cm. per min. Hence the energy of light per c.c. is nearly $6/10^5$ ergs and the light pressure therefore $6/10^5$ dynes per sq. cm. on a black surface. But at the sun's surface this pressure is 46,000 times greater, or 2·75 dynes per sq. cm. As this pressure varies as the square of the linear dimensions of the particle whilst gravitation varies as the cube, it is clear that as the dimensions of a particle decrease a limit will be reached at which the light pressure will overbalance the gravitation attraction.

It is easy to prove from known data that at or near the sun's surfaces black particles of the density of water would be just repelled if they had diameters of 15,000 Å.U. $= 150/10^6$ cm.

If their density is 5·5, then the critical diameter

will be 2700 Å.U. If, however, the particles have diameters of only 1600 Å.U. and unit density the light pressure will be nineteen times greater than the gravitation attraction. For sizes still smaller the light pressure would decrease again, and for diameters less than 500 Å.U. gravity would once more preponderate.

If, then, the solar eruptions drive up into colder regions vapours which are condensed to liquid or solid particles, a sorting action will at once come into play. Particles above a certain diameter will be drawn back into the sun. Particles below a certain diameter will be repelled away with great force by light pressure, and particles of a certain critical diameter will remain suspended in space. The solar corona may perhaps be in part composed of solar dust of this critical diameter, as Arrhenius has suggested. Now, as regards that dust which is repelled by the sun, it is easy to calculate the time particles of certain sizes will take to travel to the earth's orbit and the velocities they will then possess. Taking the particles to have unit density and three sizes, viz. 1600, 5000, and 10,000 Å.U., and to be projected from the sun with velocities of 200 km. per sec., I find that the times required to travel to the earth's orbit will be respectively twenty-two hours, forty-two hours, and seventy-six hours. The velocities with which they will arrive will be 1700 km. per sec., 780 km. per sec., and 350 km. per sec. respectively.

These minute particles, composed, it may be, of carbon from the photosphere or metallic dust from the reversing layer or volcanic ash or other solar materials will in general carry electric charges. The high temperature will cause emission of electrons from the metallic particles, as also will the fierce ultra-violet radiation to which they are exposed. The metallic vapours will also be in a state of ionisation, and the free electrons emitted will condense round them gases or vapours from the chromosphere as they pass through it. Hence the particles which are repelled by light may be either positively or negatively electrified or neutral. Owing to the greater tendency of negative electrons to condense vapours and attach themselves to groups of molecules, the negatively charged particles may be less dense and smaller than those positively charged. It should be noted, however, that isolated molecules or electrons are far too small in diameter to be repelled by light. It is only groups of molecules of at least 500 Å.U. in diameter which can be repelled. Hence these dust particles will travel outwards from the sun with very different velocities. Some will come with great velocity and others with small speed.

In short, we may say that the sun, like a good housemaid, dislikes dust, especially dust of a certain degree of fineness, and pushes it away from it with great force. The moment that this electrified dust enters the earth's magnetic field with high velocity forces will be brought to bear on it tending to separate the negatively and the positively charged particles. If H is the magnetic force of the earth and v the particle's velocity, and e its charge, then the separating force is Hev where H is that component of magnetic force at right angles to the direction of v and the separating force is also at right angles to the plane of H and v.

(To be continued.)

Obituary.

Sir Ernest Shackleton, C.V.O.

THE sudden death of Sir Ernest Shackleton on board the *Quest* at South Georgia on January 5 stopped the career of the most brilliant of Antarctic explorers just on the threshold of the South Polar regions which he was entering for the fifth time with his third expedition. That such a courageous and indomitable explorer should die a natural death after a lifetime of hair-breadth escapes from perils of ice, of starvation, of shipwreck, and of war is a grim stroke of Nature's irony. Great as his loss is to geographical exploration, we cannot but recognise his end as happy, for his life was arrested in the full course of the enthusiastic pursuit of a great and crowning adventure. The sympathy of all who appreciate high-hearted deeds will flow towards his wife, to whose co-operation much of his success was due; towards his shipmates, who have nobly resolved to carry on the voyage; and towards Mr. John Q. Rowett, whose friendship for Shackleton made him undertake the main financial burden of the expedition.

Ernest Henry Shackleton was born at Kilkee, in Ireland, in 1874, removed to London with his father while still a schoolboy, and at an early age insisted on going to sea instead of following his father's profession of medicine. After voyages to South America and other parts of the world, he entered the service of the Union Castle Co., where he was during the stirring days of the Boer War. He had become an officer of the Royal Naval Reserve before the plans of the Antarctic expedition on the *Discovery* fired him with the desire for exploration. His application for a post on the expedition was refused, persisted in, and finally accepted, and he had a strenuous time on board as junior watch-keeping officer. The expedition sailed in August, 1901, and from the outset Shackleton was eager to undertake every piece of voluntary work. He assisted in the chemical and oceanographical observations, assumed the editorship of the *South Polar Times*, and read up the history of polar exploration. When Capt. Scott was making up his party for the great southern journey of 1902–3 he included Shackleton, who thus took part in establishing the "farthest south" of lat. 82° 17′ S., and saw the great range of mountains bordering the Ice Barrier on the west and stretching far to the southward. On the return journey Shackleton broke down from an illness which was probably scurvy, but he struggled on to

the end without giving in, and only last year he refuted with the utmost indignation a published statement that he had been dragged on a sledge by his comrades on that occasion. He was much distressed at the decision that he should return home by the relief ship, and it may well be that this fact was the germ of the determination to return to the Antarctic with an expedition of his own. Shackleton had more than recovered by the time he reached England, and his health never gave way again.

In 1904 he became secretary of the Royal Scottish Geographical Society and took up his residence in Edinburgh after his marriage to Emily, daughter of the late Mr. Charles Dorman. It is scarcely too much to say that the breezy energy of the new secretary electrified the society. Unheard-of innovations were installed, unprecedented expenses undertaken, and a harvest of new members justified every reform. At the general election of 1906 he appeared as the Unionist candidate for Dundee and conducted a vivacious though unsuccessful campaign.

After this, secretarial duties proved too commonplace, and for a time Shackleton found a freer vent for his energies in business life, taking part in one of the great shipbuilding and engineering works on the Clyde. But all the time unseen lines of force were holding his ambition true to the south, and silently but solidly he laid his plans. He bought an old whaler, the *Nimrod*, raised a considerable sum of money under his personal guarantee of repayment if the expedition proved a success, and, profiting by the mistakes of the *Discovery* expedition, he had all his provisions prepared, packed, and stowed under his personal inspection. He had no committee and no orders, but held himself free to carry out his own plans in his own way at his own risk. He decided to base his transport on ponies and motor haulage, methods never used before in polar exploration, and although the motor broke down at an early stage, the ponies brought the expedition to a point on the barrier beyond that reached in the *Discovery* expedition, and but for the loss in a crevasse of the last pony, the South Pole would have been reached. An ascent to the plateau was found by the Beardmore Glacier, and when it was clear that the provisions could not carry the party all the way and back, Shackleton turned in lat. 88° 23′ S. Had he pushed on for another day before turning he would have met the fate which afterwards befell Scott, and, indeed, he very narrowly missed it. On this expedition there were many innovations in food, in lighting, and for the first time it carried a kinematograph into the polar regions.

On his return in 1909 the recognition of the epoch-making advances in methods and results was widespread, if not universal, and the splendid achievement of David and Mawson in reaching first the summit of Mount Erebus and then the Magnetic Pole, together with the biological, meteorological, and geological work of all the parties, gave the expedition, as a whole, high scientific value. Shackleton received a shower of gold medals from the geographical societies of the world and the honour of knighthood. He passed a strenuous year or two lecturing in Europe and America to pay off the debts of the expedition and the expense of the scientific reports.

The attainment of the South Pole by Amundsen and Scott in 1912 turned Shackleton's attention to the project of crossing the Antarctic continent by landing on the shores of the Weddell Sea and marching *via* the Pole to his old quarters on the Ross Sea. Again his word was sufficient security for the advance of funds, and again the plan was his own. The war broke out after his start in the first week of August, 1914, and he at once placed ships, stores, and men at the disposal of the Government for military service. The offer was declined, and the expedition sailed. The Ross Sea party carried out its programme and laid a chain of *depôts* from Macmurdo Strait to the Beardmore Glacier, but the men were imprisoned at their winter quarters by the drifting away of their ship, the *Aurora*. Meanwhile, Shackleton, in the *Endurance*, had carried the exploration of Coats Land farther south than its discoverer, Bruce, or his German follower, Filchner; but just when a landing was almost in sight the ship was caught and drifted northward fast in the ice step by step with the *Aurora* on the other side of the world.

The *Endurance* was crushed and sank, but Shackleton and his party kept up their courage through a dreadful year of inaction. Where reckless daring was the only course everyone knew that he would dare all; but it was a revelation to most of us to find that when safety lay in caution he could command the eager spirits of his companions to patience. When a landing was made on Elephant Island he at once decided to make for South Georgia, 800 miles away, in a little open boat with a few volunteers, and seek help for the others, who remained under the charge of Frank Wild. He made the almost impossible voyage, well knowing that if he survived and the party on Elephant Island perished he would be charged with deserting them and seeking his own safety, and to face this possibility was a greater test of courage than the Southern Ocean itself. He succeeded after three failures in bringing every man who sailed in the *Endurance* back alive to South America in August, 1916.

Hurrying to New Zealand, he found that the authorities who had repaired and equipped the *Aurora* to rescue his Ross Island party refused to allow him to take charge of his own ship to look for his own men; but he felt his responsibility so keenly that with an almost unbelievable magnanimity he accepted the situation and shipped as a common sailor on the relief voyage. Never was a case where failure was so nobly retrieved, and the failure had occurred only because the forces of Nature are stronger than the resources of the most heroic man.

For two years Shackleton served in the army as officer in charge of the supplies for the British force operating in the White Sea and Northern Russia. Then for another feverish spell he threw all his energies into lecturing on his last expedition to enable

him to repay the advances which had been made to him. Once out of debt, he found the call of the ice irresistible. He meditated a dash to the unknown centre of the Beaufort Sea in the Arctic regions, and had gone far to mature his plans when circumstances barred the way, and he resolved on one more Antarctic voyage.

This time the munificence of friends secured him freedom from financial worries. His plan was sound; the Enderby Quadrant which he was to explore was practically unknown; his old comrades rallied to him from the ends of the earth; but the ship was small though stout, and he was forty-seven years old, though a boy at heart. He sailed in the *Quest* in September, 1921, had a grievous buffeting on the voyage to Madeira, a long and trying delay for refitting in the heat of Rio de Janeiro, again a stormy voyage to South Georgia, and then the sudden seizure in the midst of apparent health, and the career of the most Elizabethan of modern explorers had an end as abrupt as the clash of "the blind Fury with the abhorred shears."

Shackleton lived like a mighty rushing wind, and the very strength of his nature made him enemies as well as friends. He resented injustice and slights, but they only spurred him on to show by new achievements how baseless they were. He endeared himself to his friends, and was adored by his ship-mates, who saw in "the Boss" a kindly but unquestionable authority. He loved applause and gloried in the limelight; but he was applauded for feats that no one else was able to accomplish. The labourer is worthy of his hire, and no one has a right to quarrel with a good workman if he likes to take some of his pay in the form of praise and publicity.

Shackleton's most characteristic quality was neither courage nor resolution, both of which he shared with other heroes of exploration. It was his instinctive judgment. Whenever he had to make a decision between two courses of action, no matter how suddenly the necessity arose nor how quickly it had to be met, he invariably did the right thing. Again and again the wrong decision would have meant certain death or irremediable disaster. This power of decision was not an effort of reason, but an apparently instinctive impulse which can perhaps be accounted for by a peculiar balance of perception. Indeed, it is to the balancing of contradictory qualities that much of Shackleton's success was due. His mind was not essentially scientific, though he valued science and made most generous provision for it in his expeditions. He was both impulsive and cautious, yet he was never irresolute. He revelled in poetry and seemed to breathe the air of romance, but at the same time he was a methodical organiser and a keen business man. His imagination was amazingly fertile, and it seems as if in planning an expedition he imaged to himself everything that could possibly happen in any set of circumstances and then set himself to work to provide for each contingency. Whatever may have been its secret, his personality was his greatest power, and it marked him out as a commanding figure. He might well have been a Drake or a Ralegh; in no time and in no conditions could he have been commonplace. The greatness of his loss may be judged by the things he did and the way he did them.

HUGH ROBERT MILL.

SIR WILLIAM CHRISTIE, K.C.B., F.R.S.

WILLIAM HENRY MAHONEY CHRISTIE was the youngest son of Samuel Hunter Christie, professor of mathematics in the Royal Military Academy at Woolwich and secretary of the Royal Society from 1837 to 1854. He was born in 1845, the same year as George Darwin and two years later than David Gill. Educated at King's College School and Trinity College, Cambridge, he was fourth wrangler in 1868, and in the following year was elected to a fellowship of his college. On the recommendation of Airy, Christie was, in the autumn of 1870, appointed chief assistant at the Royal Observatory, Greenwich. At that time the activity of the Observatory was largely concentrated on its traditional duty of the regular observation of sun, moon, planets, and fundamental stars, the stars being regarded as points of reference for the planets, and especially the moon, and serving also for the determination of time. The observations were made with the transit circle erected by Airy in 1850. Christie made a careful study of (1) the most suitable value of the refraction constant at Greenwich, (2) the corrections to be applied for a well-established and persistent difference between the zenith distances of stars when observed by reflection from mercury and when observed directly, and (3) the value of the latitude at Greenwich—data required to deduce the declinations of stars free from systematic errors. In this involved and somewhat indeterminate problem his judgment was correct, as is shown by the smallness of the systematic corrections applicable to the Greenwich catalogues of 1880, 1890, and 1900 to bring them into accord with the mean of other observatories.

The extension of the field of work of the Observatory was pressed on Airy by Warren de la Rue, who advocated continuous observations of sun spots, and by Huggins, who advocated spectroscopic observations of sun and stars. In a letter to Airy in May, 1872, Huggins writes: "I understand Mr. Christie, who is zealous in the matter, to say that you would be agreeable to this course." Government sanction was obtained, and Mr. E. W. Maunder was appointed assistant for photographic and spectroscopic observations. Christie was in sympathy with both these extensions of the activity of the Observatory. The photo-heliographic work was carried through very successfully, and arrangements made with the Solar Physics Committee, and later with the Cape and Kodaikanal Observatories, resulted in a uniform and continuous series of photographs of the sun being taken day by day, which were afterwards measured and discussed at Greenwich with reference to the positions and areas of sun spots.

The spectroscopic observations for velocity in the line of sight were not successful. It was not until the introduction of photography by Vogel that any reliance could be placed on line of sight determina-

tions of velocity, and not until the Mills spectrograph at the Lick Observatory was got into operation in 1895 by Campbell that thoroughly trustworthy results were obtained. But the earlier observers in the field, as in the parallel case of parallax determinations, deserve credit for attacking an important problem, though they did not succeed in overcoming the great difficulties which it presented.

On the retirement of Airy, in 1881, Christie was appointed Astronomer Royal. His tenure of office is notable for the large additions he made to the equipment of the Observatory and to the introduction of stellar photography. The first extension of the buildings was an additional computing room, and with it a pier and dome, which served later for the astrographic equatorial. In 1885 he represented to the Admiralty the desirability of increasing the optical means of the Observatory, and received its assent to the purchase of an object-glass of 28-in. aperture and 28-ft. focal length. In co-operation with Stokes an object-glass was proposed which might be used for visual or photographic observations. This telescope, constructed by Sir Howard Grubb, was completed in 1893 and installed on the equatorial mounting which until then had carried the Merz 12¾-in. telescope. The drum-shaped dome covering the Merz refractor was worn out, and was replaced by an Oriental-looking dome designed by Christie to contain the longer telescope. This telescope was for many years in charge of Mr. Lewis, and has been utilised for a valuable series of observations of double stars.

The provision of the photographic refractor of 13 in. with a 10-in. guiding telescope, to enable Greenwich to take part in the photographic mapping of the heavens, was sanctioned in 1888. The instrument, constructed by Sir Howard Grubb, was mounted in the 18-ft. dome over the computing rooms in 1890. The Greenwich section of the astrographic chart and catalogue and the observations of Eros for solar parallax were made with this telescope. Christie took a share in the deliberations and arrangements for this international undertaking. He designed a micrometer for use at Greenwich which facilitated the comparison of neighbouring plates. He was also the discoverer of a very useful empirical formula connecting the magnitude of stars with the diameter of their photographic images.

The largest addition to the Observatory was commenced in 1890, but not completed until 1898. It is a cruciform building, with office rooms on the ground floor, libraries and workshop in the basement, rooms for preserving records and photographs on the upper floor. The central octagon is used as a store room, and is surmounted by a 36-ft. dome originally built to cover Lassell's 2-ft. mirror presented to the Observatory by the Misses Lassell. Before the building was completed Sir Henry Thompson generously offered to provide a 26-in. photographic refractor and a 30-in. reflector, both on the same equatorial mounting. The equatorial and the refractor were constructed by Sir Howard Grubb and the mirror by Dr. Common. The refractor was used in observations of Eros, observations of Neptune's satellites, and for various other purposes, while the reflector was used in photography of nebulæ, observations of small planets, comets, faint satellites, etc., and was instrumental in the discovery of the eighth satellite of Jupiter.

About the same time Christie designed a new altazimuth. The instrument is essentially a transit circle which can be mounted in any azimuth. It replaced Airy's altazimuth, which did not give sufficient accuracy. The new instrument usefully supplements the observations of the moon made with the transit circle.

These various extensions to the Observatory buildings cramped the space for meteorological observations, and the iron in the domes affected the magnets, which were housed in a wooden building a few yards to the north of the new observatory. A plot of ground in Greenwich Park was lent to the Admiralty by the Office of Works, where a magnetic pavilion was erected for taking absolute magnetic observations.

Christie took a good deal of interest in the observation of total eclipses. He went to Japan in 1896, to India in 1898, to Portugal in 1900, and Tunis in 1905. With the equipment arranged by him in 1896 an excellent series of large-scale photographs of the corona were taken at the eclipses of 1898, 1900, 1901, 1905, and 1914.

Christie retired from his office on his sixty-fifth birthday, October 10, 1910, with the good wishes of his staff. He maintained his interest in the Observatory, and came regularly to the annual visitation. He was also frequently at the meetings of the Royal Astronomical Society and the Royal Society, serving on the council of the Royal Society six years and on that of the Royal Astronomical Society forty-one years, being president in the years 1888–1890. Several foreign academies also accorded him honours. He received the distinction of C.B. on the occasion of Queen Victoria's Diamond Jubilee and was promoted K.C.B. in 1904.

He married in 1881 Violette Mary, daughter of Sir Alfred Hickman, of Wolverhampton. Mrs. Christie died in 1888, leaving two sons, one of whom died in childhood. His elder son, Mr. Harold Christie, lived at the Observatory until his father retired, when they went to live first at Woldingham and afterwards at Downe. Sir William was of a courteous and hospitable disposition, and would always invite some members of his staff to meet a foreign astronomer who might be visiting the Observatory. He thoroughly enjoyed astronomical conferences and eclipse expeditions for the opportunities they afforded of meeting astronomical colleagues. He acquired in these expeditions a love of sea voyages, and after his retirement made several trips abroad in the winter. In the early part of 1921 he went to Jamaica, and paid a visit to Mr. and Mrs. Pickering at the observatory of Mandeville. This year he started for Mogador a few days after meeting many of his friends at the Royal Astronomical Society Club. He was then apparently in fair health, but died on January 22, before the ship reached Gibraltar.

F. W. DYSON.

Dr. Emile Cartailhac.

We regret to record the death of Dr. Emile Cartailhac on November 25 at Geneva, where he had just completed a course of lectures delivered at the invitation of the University. Emile Cartailhac was born at Camarès in 1844, and for more than fifty years had been one of the dominant figures in the study of prehistoric archæology in France. His work in archæology began when the discoveries of Boucher de Perthes were still the subject of controversy, and he threw himself with characteristic ardour into the discussion. He settled early at Toulouse, and founded there in 1866 a museum of human palæontology. His success as a lecturer was immediate, and eventually led to his appointment as professor of prehistoric archæology, the only appointment of the kind in France. From 1869 onward he edited the well-known publication, "Matériaux pour servir à l'Histoire primitive et naturelle de l'Homme," with conspicuous ability; but his greatest contribution to prehistoric archæology was his synthetic study of the prehistory of France which appeared in 1889 under the title, "La France préhistorique d'après les sépultures et les monuments." This book, the first of its kind, has gone through numerous editions. Of his other writings, which were numerous, the most important were "Ages préhistoriques de l'Espagne et du Portugal," the volume dealing with the rock paintings of Altamira in the series published under the auspices of the Prince of Monaco, written in conjunction with the Abbé Breuil, and the archæological section of "Les Grottes de Grimaldi."

Mr. Mansel Longworth-Dames, whose death in his seventy-second year is reported, entered the Indian Civil Service in 1868. He served in the Punjab for twenty-eight years, with an interlude in 1879, when he was on duty with the troops in the second Afghan war. While he was stationed in the trans-Indus districts he acquired a good knowledge of the Baluch tribes and of their language; he published a Baluchi grammar and reading-book, which were for many years used by students; an account of the Baluch race, issued by the Royal Asiatic Society; and "The Popular Poetry of the Baluchis," published by the Folklore Society. He made a large collection of Buddhist art, which passed into the hands of the Berlin Museum, and he helped to arrange the Buddhist rooms of the British Museum. He was an active member of the Royal Asiatic Society, of which he was vice-president. He knew Arabic, Persian, and Portuguese well, and this knowledge he utilised in his new translation, with copious annotations, of "The Book of Duarte Barbosa," published last year by the Hakluyt Society. His death leaves a gap in the small circle of oriental scholars.

We regret to report the death of Mr. C. F. T. Hadrill, clerk in the General Library of the British Museum (Natural History). Seized on January 12 with influenza while on his way home from the Museum, he succumbed to its effects within four days, on the evening of January 16. Mr. Hadrill first took service with the Trustees in the Copyright Office at the British Museum, Bloomsbury, in 1888. Thence he was transferred to the General Library at the South Kensington division of the Museum in 1895. Save for the period of his war service (1915 to 1919), he held his position continuously up to the day of his death. Thoroughly interested in his work, in which he took great pride, he was intimately acquainted with the books under his charge, as all who came into contact with him, whether Museum officials, or students, or casual visitors, soon realised; and his services, always most willingly, obligingly, and efficiently rendered, were consequently in perpetual demand. His loss will be felt as a personal one by a large circle of scientific workers, including those connected with the "Zoological Record," for which he was one of the researchers.

Notes.

The Bakerian lecture of the Royal Society will be delivered on March 9 by Prof. T. R. Merton and Mr. S. Barratt on "The Spectrum of Hydrogen."

The fifth Silvanus Thompson memorial lecture of the Röntgen Society will be delivered by Sir Oliver Lodge at the Institution of Electrical Engineers on Tuesday, March 21.

At a meeting of various sections of the welding industry held on January 26 it was resolved that a new society, to be known as the Institution of Welding Engineers, be formed. The society will embrace all systems of welding, and anyone who is interested in welding and allied industries will be eligible for membership. The hon. secretary (*pro tem.*) is Mr. C. Raggett, and the temporary home of the new institution is at 30 Red Lion Square, London, W.C.1.

Information has reached us from Mr. D. H. Cain, 13 Duke Street, St. James's, S.W.1, that an English company, known as Radium Ore Mines, Ltd., is to re-open the Tolgarrick radium mine situated near Truro. According to this announcement, the mine was abandoned at the outbreak of the war, but is already installed with all the plant necessary for immediate resumption of work. Two rich lodes of uranium ore are to be worked, and the intention is to treat the ore on the spot. The development of radium spas in this connection is also foreshadowed.

Two noteworthy prizes for the discovery of a cure for cancer have recently been announced, namely, one by Lord Atholstan of 100,000 dollars, and the other by Sir William Veno of 10,000*l*. Both prizes are limited to students and graduates of recognised universities, and they will be awarded to the first investigator who within the next five years succeeds in discovering a non-surgical effective cure for cancer. The awards will be made on the decision of the Royal Colleges of Physicians and Surgeons in London.

At the monthly meeting of the Zoological Society of London, held on January 18, the secretary reported that seventy-nine additions had been made to the society's menagerie during the month—thirty by presentation, thirty-nine deposited, and ten by purchase. The most noteworthy addition to the collections is a pair of lions from India, presented by H.M. the King. The number of visitors to the gardens during 1921 was 1,386,745, and the receipts for admission amounted to 46,509*l*. Four hundred and seven new fellows were elected to the society during the year, and while this number is 123 fewer than in the previous year, it is 95 above the average for the last ten years. These figures are eloquent of the popularity of this institution.

A movement has been set on foot to erect a fitting memorial to the great sanitarian, William Crawford Gorgas, through whose labours it became possible to complete the construction of the Panama Canal. Inaugurated by Dr. Belisario Porras, the President of the Republic of Panama, the scheme aims at the erection of a hospital and laboratory for tropical and preventive medicine. The Panama Government has provided a site, a building, and modern equipment valued at half a million dollars, as well as the use of the two-million-dollar Santo Tomas Hospital, which is just being completed. It is hoped to increase the initial sum available by another four and a half million dollars by means of contributions from the public and the Governments which have benefited from the work of Gorgas. A provisional board of directors for the United States has been appointed. The laboratories to be built will resemble the Pan-American buildings in Washington, while Dr. R. P. Strong, of the Harvard School of Tropical Medicine, is to be the scientific director of the memorial.

Shortly after the retirement of Prof. P. F. Frankland from the Mason chair of physics in the University of Birmingham a fund was opened with the object of providing some permanent memorial of his work in the University. The money subscribed was devoted in the first place to a portrait of Prof. Frankland (painted by Mr. Bernard Munns), which now hangs in the great hall of the University at Edgbaston. The balance of the fund has been applied to the institution of a Frankland medal, which, together with a prize of books, is to be presented annually to the best student in practical chemistry. The medal is of bronze, bearing on the obverse a profile portrait of Prof. Frankland, and on the reverse the arms of the University. A handsome book-plate has also been designed to be placed in the prize-books. The name of this distinguished chemist will thus be kept green in the memory of future generations of students, and the prize will doubtless act as a stimulus to the attainment of excellence in the practical study of chemistry, on the importance of which Prof. Frankland so wisely insisted.

The Gypsy Lore Society, founded in 1888 by Mr. David MacRitchie to promote the study of the language, history, ethnology, and folk-lore of the gypsy race, continued its useful career until its publications were suspended in 1892. After fifteen years it was revived under the direction of Mr. R. A. Scott Macfie, but its work again ceased owing to the war in 1914. We are glad to learn that the society has now been revived again under the presidency of Mr. W. Ferguson, with Mr. T. W. Thompson as honorary secretary. The address of the honorary treasurer, to whom the subscription of 1*l*. per annum is payable, is 7 Macdonald Road, Friern Barnet, London, N.11. The society in its new form has received the support of several eminent scholars interested in the subject, and many valuable contributions have been promised. The study of the gypsies is to be commended from many points of view and we trust that the society will receive generous support and meet with the success which it deserves.

In 1821 some residents of New South Wales of a scientific turn of mind founded the Philosophical Society of Australasia, the first scientific society to be formed in Australia. The society did not continue its meetings for long, and while other societies devoted to agriculture, horticulture, botany, etc., were formed, it was not until 1850 that a society for general science known as the Australian Philosophical Society, with Sir Thomas Brisbane as president, came again into existence. Only two members of the original society were also members of the 1850 society, namely, Alexander Berry and Dr. H. G. Douglass, the latter of whom was honorary secretary of both societies. In 1855 the name was changed to the Philosophical Society of New South Wales, and in 1866 this name gave place to that of the Royal Society of New South Wales, which it still bears. To commemorate the centenary of the foundation of the parent society, members of the Royal Society of New South Wales visited Kurnell on December 10 last, where the president and members of the original society had erected a brass tablet in memory of the landing of "James Cook and Joseph Banks."

Influenza in London had very appreciably decreased according to the deaths given in the Registrar-General's return for the week ending January 21; the decrease compared with the preceding week was 108. In the ninety-six great towns of England and Wales the deaths had increased in the corresponding period by 164, but there seems a good prospect that the improvement shown in London will extend to other parts of England. Of the total deaths from influenza in London during the week 56 per cent. occurred between the ages of forty-five and seventy-five. In London there have been with the present attack thirty-one epidemics since 1890, considering a well-established 20 or more deaths per week as epidemic. The only years without an epidemic are 1896 and 1901, and of the thirty epidemics preceding the present, twenty-seven have occurred in March, twenty-four in February, eighteen in April, and seventeen in January. Not one has been existent in September, only one in August, two in July and October, and three in June. The complaint is essentially epidemic in winter and spring, but there seems little

indication of it being helped or hindered by spells of heat or cold.

English engineers are glad that it is highly probable that the contract for the electrification of the South African Railway between Pietermaritzburg and Glencoe will be given to the Metropolitan-Vickers Co., of Manchester. In the early days of the electrical industry in South Africa German competition was severely felt, but much of the foreign-made plant then purchased has given great trouble to the users, due not only to faulty design, but also to the fact that it got much too hot at full load. English machines were found to be more desirable. The contract will involve the construction of seventy locomotives. The line carries very heavy mineral traffic on its way to the coast in Natal and goes through a hilly district. It is, therefore, very suitable for electric traction, as regenerative braking can be used on the descending grades. In addition to pumping back into the line most of the potential energy lost, it obviates all the wear and tear on wheels and brake-shoes inevitable with steam traction. Each of the locomotives will be equipped with four large electric motors, and the construction of these and the necessary control gear will, unless the unforeseen happens, provide employment for many workpeople in Sheffield and Manchester.

The thirteenth meeting of the International Geological Congress is to be held in Brussels on August 10–19. Excursions to places of geological interest in Belgium will be held before the congress, on August 1–9, and afterwards from August 21–September 3. An interesting programme of geological discussions on subjects including tectonics, the geology of the Carboniferous system and of petroleum, and the geology of Africa—a subject to which Belgian geologists have contributed greatly. The committee of organisation has decided not to admit ". . . nationals of those countries lately at war, in defiance of Treaty obligations, with Belgium"—a phrase which only an international lawyer could confidently interpret. It might be intended to exclude Germans only, but might admit of considerable extension. The admission of Germans and Austrians to the social functions of the congress might be reasonably regarded as premature, but their complete exclusion from an international scientific congress will be regretted by many British geologists. The president of the organising committee, who will naturally be president of the congress, is M. J. Lebacqz, Director-General of Mines, and president of the Geological Council in Belgium. The secretary is M. Renier, the head of the Geological Survey of Belgium. There will be five excursions before the congress to examine respectively the central and eastern districts, the Tertiary beds, the Devonian, and building materials. There will also be ten local excursions, most of which are for a single day, during the congress. Five excursions after the congress will be devoted to the study of the Cretaceous and Tertiary rocks near Mons, the metamorphic rocks at Bastogne, the Palæozoic tectonics, the Carboniferous limestones, and the Westphalian. These excursions vary from four to twelve days.

The Secretary of State for Air, Capt. Guest, received a deputation from the council of the Royal Aeronautical Society on January 17 and heard views for safeguarding the applied scientific research of the Air Ministry. Attention was directed to the danger of dealing exclusively with the needs of the moment, particularly by routine methods, and to the fact that present and future economy called for systematic inquiry on scientific principles. The high insurance rates required to cover aviation risks and the loss of the airship R38 are instances which will occur to readers of Nature as matters needing more than passing attention. The deputation consisted of Col. M. O'Gorman (chairman), Prof. L. Bairstow, Sir Mackenzie Chalmers, Prof. B. M. Jones, and Lt.-Col. A. Ogilvie, and represented the council of the Royal Aeronautical Society, except that Service members felt that their appointments debarred them from expressing an opinion. A marked distinction was made between "applied scientific research" and "*ad hoc* experiments," and it was stated that experience showed that the latter take precedence and tend to the extinction of research on the ground of urgency when both are under a common direction. The cessation of airship research both on the full scale and in the laboratory and the proposal to close the Aerodynamics Department of the National Physical Laboratory (happily not being fully pressed) indicate how serious has been the position in the past year. The deputation suggested that the remedy lay in the appointment of a scientifically trained head of a department specially devoted to applied scientific research. As applied to a new science the difficulties are great, but it is understood that the proposals are receiving the serious and sympathetic consideration of the Secretary of State for Air.

The report of the "Wireless" Telegraphy Commission which has just been issued is of value, as it represents the reasoned and deliberate judgment of three well-known experts. In his preface Dr. Eccles comments on the "severely technical" nature of the report, but as the terms of reference definitely ask for advice on the preparation of specifications for machinery and apparatus this was unavoidable. The Commission is to be congratulated on the thoroughness with which it has done its work. As in all engineering projects, however, unless the scheme is begun at once further discoveries may make it advisable to alter appreciably the detailed specifications. It recommends that a radio-chain be established, none of the steps being greater than about 2000 miles. The radiotelegraphic energy is to be generated by thermionic valves. The first step is to be from Leafield to Cairo, which the Post Office will shortly operate by means of Poulsen arcs. Then valve stations will be erected at Poona, Singapore, Hong Kong, and in Australia at either Port Darwin or Perth. Valve stations would also connect England and Canada. The stations are to be capable of delivering at least 120 kilowatts to the antenna. They will be larger, therefore, than the Carnarvon station of the Marconi Company. It has been found that there is a considerable loss of

energy due to the induced currents in the earth under the antennæ. The Commission therefore advises that efficient earth-screens made of grids of copper wire be used at all the chain stations. It is suggested that the Marconi Company be invited to tender for earth-screens, antenna tuning coils, and thermionic-valve sets. It also suggests that if their tender be not acceptable, suitable plant could be designed by the Commission after the conclusion of the work now being undertaken at Horsea.

THE last annual report from the Field Museum of Natural History at Chicago deals with the highly successful removal of the collections from the building in Jackson Park to a new building in Grant Park. The Section of Plant Reproduction continued to turn out those beautiful models of vegetable structure on which we have commented in previous years. In addition to several fruits and flowers, the reproductions include the green algæ, Œdogonium and Ulothrix, enlarged tip of a frond of the alga, *Bryopsis plumosa*, a cotton plant, and a cycad, *Zamia floridana*. Another reproduction illustrated, but not otherwise mentioned, in this report is a restoration of the New Zealand moa, 13 ft. high. We do not know which species of Dinornis this professes to represent, but it seems to have an abnormal number of cervical vertebræ, a mammalian back, and pantomime legs.

IN "La Cité des Termites" Dr. J. Feytaud gives a very interesting account of the social habits of *Leucotermes lucifugus*, Rossi. The author has had excellent opportunities to study this species of white ant (one of the two species of the family found in Europe) at first hand in the south-west of France, and he has made good use of them. The brochure contains one of the most complete studies of the life and habits of the termites that we have. Much of the information has appeared in scientific journals, but now that the author has brought his studies together into one volume the intricate and elaborate social life that exists amongst termites should become more widely known. A chapter is devoted to the ravages and means of destruction of termites.

SOME interesting anthropological data relating to the Pitcairn Islanders, the descendants of the mutineers of the *Bounty*, are contained in an appendix by Dr. D. Colquhoun, of Dunedin, New Zealand, to a report on a visit paid in June last to Pitcairn Island by Sir Cecil Rodwell, High Commissioner of the Western Pacific (Colonial Reports—Miscellaneous: No. 93). The present inhabitants, who number 174, are the descendants of forty of the islanders who, in 1859, returned to Pitcairn from Norfolk Island, whither the whole population of 190 had migrated in 1856. Dr. Colquhoun describes the islanders as lighter in complexion than pure Maoris, and says many would pass for southern Europeans. The hair is generally dark and straight, although one individual had the frizzy hair, dark skin, and thick lips of a Melanesian type, and two children had fair hair and blue-grey eyes. Generally the eyes are dark brown, rarely bluish-grey. All the islanders are dolichocephalic. No stigmata of the degeneration through in-breeding, which was anticipated from the evidence afforded by Admiral Palliser's visit to the island in 1898, were observed, and the island is singularly free from disease. Copies of the report may be obtained from H.M. Stationery Office, Imperial House, Kingsway, W.C., price 10*d*.

RÉSEAU MONDIALE, 1914, has recently been published by the Meteorological Office of the Air Ministry. The preface to the work is written by Sir Napier Shaw. The present volume completes five years of the publication, 1910 to 1914, which will afford some idea of the value of the compilation of meteorological data for the whole globe which it has been the ambition of meteorologists to achieve for a long time past. Data for 1914 were not obtainable until some time after the war, and information for many of the Siberian stations is still lacking. The number of stations recorded for the present volume is 392. Two stations are chosen for each ten-degree square, and the results are given for each month and for the year. For barometric pressure the mean is shown with the difference from the normal. For temperature the mean maximum and mean minimum values are tabulated with the mean of the maximum and minimum and the difference from the normal, together with the absolute maximum and absolute minimum temperatures experienced. For rainfall the total precipitation is given and the difference from the normal.

THE report of a general discussion on the physics and chemistry of colloids, held jointly by the Faraday Society and the Physical Society of London, has been issued by the Stationery Office at the price of 2*s*. 6*d*. It includes nearly thirty formal papers on colloids, in addition to the discussions arising therefrom. Special attention may be directed to the brilliantly lucid "Survey of the Physics and Chemistry of Colloids," by Prof. Svedberg, of Upsala, with which the proceedings were opened. The essential outlines have been drawn with a clearness and firmness of touch that has never before been equalled, whilst the bibliography at the end of the paper shows where the details required to complete the picture may be found.

THE demand for very penetrating X-rays for purposes of medical therapy has led to the construction of high-tension apparatus capable of giving a continuous output for several hours of current at an alternative spark-gap up to about 18 in. This has caused considerable modifications in the design of both induction coils and interrupterless transformers. A circular on "Deep Therapy Apparatus, Section 2b," issued by Messrs. Newton and Wright, Ltd., gives a description of an induction coil designed for this type of work. The coil really consists of two symmetrical coils mounted side by side, the whole being immersed in oil; this latter avoids breakdowns due to insulation troubles produced by the high-tension discharges in the air in the interior of the coil. A useful feature of the double-

coil design is that it allows the milli-ampere meter to be inserted at the mid-point, which is at zero potential, and hence the instrument can be brought to an ordinary low-tension switchboard.

AN account of the discussion on the future of geometrical optics which took place at the Cambridge meeting of the Optical Society in May last is given in part 5 of the Transactions of the society for the present session. On the whole, the representatives of the manufacturers were in favour of retaining the step-by-step trigonometrical method of tracing rays through the system under design in order to get rid of aberrations rather than changing to the analytical methods, which give the aberrations of the first order in terms of a certain quartic in the magnification and those of the second order in terms of

$$M(1+AM)/(1+BM),$$

where A and B are constants and M is the square of the inclination of the ray to the axis. It was, however, suggested that some attempt should be made by mathematicians to reduce the complexity of the formulæ involved by bringing the subject into line with the wave theory. It was pointed out that the British optical trade must in the next four or five years improve its optical designs if it is to be able in the future to sell its products against the better designed articles offered by manufacturers of other countries.

A LIST of American research chemicals has been issued as No. 23 of the Reprint and Circular Series of the National Research Council, Washington. The list includes biological stains and indicators, and includes a very large number of fine chemicals. The number is larger than that in the corresponding list of British research chemicals, issued by the Association of British Chemical Manufacturers, but the latter is incomplete, and although not dated, was issued some time before the American list. The American list also includes many very simple derivatives, such as acetyl and benzoyl compounds, which swells its bulk. One noticeable feature of the American list is that it includes a large number of rarer inorganic chemicals likely to be required for research purposes, whilst the British list is largely made up of organic chemicals. It is desirable that a new and more complete edition of the latter should be issued as soon as possible, and that requirements in inorganic, as well as organic, chemicals should be kept in mind.

THE provision of a works laboratory is now recognised as an essential part of the organisation of any large engineering firm. The equipment will, of course, depend upon the kind of work carried out by the firm. The laboratory at the Bedford works of Messrs. W. H. Allen and Sons, Ltd., forms the subject of an illustrated article in *Engineering* for January 13, and its equipment may be taken as an excellent example of what is required by a firm manufacturing a wide range of high-grade mechanical engineering products. There is a main mechanical testing-room, a chemical laboratory with balance-room and stores, a recalescence room, a photomicrographic room, dark room, and office. The mechanical testing equipment includes a Brinell hardness machine, a Sankey autographic bending machine, machines for repeated impact testing of the Eden-Foster and Stanton types, an Izod impact machine, a 30-ton Buckton machine with a Ewing extensometer, and a Shore hardness testing machine. The same room contains a number of machine tools for the preparation of specimens. The chemical laboratory has also a very complete equipment; the recalescence furnace is a modification of the one in use in the National Physical Laboratory. It is perhaps unnecessary to add that this laboratory has exercised a very effective control over the quality of the firm's products.

AN introductory address to his lectures at University College on waterways, harbours, and docks was delivered by Dr. Brysson Cunningham on January 24. The great value of the ocean as an international waterway and the facilities it affords for traffic, with far fewer difficulties than in the case of land routes, were emphasised. Before the war railway construction in England had cost something more than 50,000*l*. per mile, including expenses of promotion, while in the United States the cost averaged only about one-fifth of this sum; the outlay for track formation proper was about 5000*l*. or 6000*l*. per mile. In both cases there is, in addition, the expense of maintenance, whereas in a waterway on the high seas there is neither cost of construction nor of upkeep. This is true, though in a lesser degree, of the rivers and inland waterways. Dr. Cunningham also discussed ports, pointing out that few modern ports have kept pace with the requirements of the naval architect in regard to ship design. Rational developments in shipbuilding are impeded by lack of depth of water at the principal ports and in the Suez Canal. The following table shows the actual rate of expansion in the dimensions of vessels in the mercantile marine during the past forty years:—

Average dimensions of the twenty largest steamships in each of the years mentioned.

	1881. Feet.	1891. Feet.	1901. Feet.	1911. Feet.	1921. Feet.
Length.. ..	460	507·0	599	703·5	735·0
Breadth ..	45	54·5	65	73·6	82·5
Depth	30	31·0	39	47·7	51·0
Loaded draught	24	27·0	32	32·5	34·0
Tonnage ..	4,900	6,980	14,150	21,600	31,550

Sir John Biles has claimed that it would be economical to construct vessels up to 1000 ft. in length provided it were possible to give them the appropriate draught of 57 ft., but there are very few ports in the world which could receive a vessel of this draught. Forty feet is the extreme limit of draught which is available at the present day for sea-going vessels.

IN the general article on "Agriculture at the British Association" in NATURE of January 5, p. 25, it was stated that "Mr. M. M. Monie gave an account of a photographic survey of soils . . . the method he proposes, while of limited use by itself, should have a useful place in soil-survey work." Mr. Monie writes to say that his remarks were "that a photographic

record of topography, soil profiles, and soil types in the field was a most useful section of my soil survey, forming about 10 per cent. of the work." As an illustration of the value of the method, he showed a telephotograph of an area covered by mounds of fluvio-glacial sands and gravels. Mr. Monie also states that the field methods he has worked out for the West of Scotland can easily be applied to give useful results over most areas.

The reviewer of the translation of Prof. le Blanc's "Text-book of Electrochemistry" in last week's Nature, p. 101, remarked that though the title-page bore the date 1920, he could find no references later than 1907. It has been pointed out to us, however, that the translation, as stated on the title-page, is of the fourth German edition, and that the author's preface to this edition, dated 1906, is printed in the volume. The translators state in their preface that the work is a translation of this edition, and at the back of the title-page are printed the words "Published March, 1907." It was not suggested by the publishers, therefore, that the work was anything more than the fourth edition; the date on the title-page was merely that of the current reprint.

Referring to the notice in Nature of January 12, p. 59, of the new petrological microscope manufactured by Messrs. R. and J. Beck, the firm wishes it to be known that the left-hand slow-motion milled head is provided with graduations each of which represents 0·01 of a millimetre.

Messrs. Bowes and Bowes, Cambridge, have just issued a MS. list of recent books dealing with mathematics on sale by them, and another of works in the German language. Messrs. H. K. Lewis and Co., Ltd., 136 Gower Street, W.C.1, have sent to us a list of the new books and new editions added to their Medical and Scientific Library during October–December. These lists and that of "Recent Scientific and Technical Books" issued with Nature of January 26 should make it possible for readers to keep abreast of current scientific literature.

Messrs. Chapman and Hall, Ltd., are about to publish a book by Dr. G. W. C. Kaye entitled "Industrial Applications of X-rays," which aims at presenting in language not too technical the various uses to which the rays can be usefully applied in commercial undertakings. Another book in the announcements list of the same publishers is "Mechanical Testing," by R. G. Batson and J. H. Hyde, 2 vols. Vol. 1, which will deal with the testing of materials, is expected to be published in February, and vol. 2, treating of the testing of apparatus, either in May or June.

Our Astronomical Column.

The Total Solar Eclipse of next September.—The Greenwich Expedition which is being sent to Christmas Island for this eclipse, consisting of Messrs. H. Spencer Jones and P. J. Melotte (the former being accompanied by his wife), sailed from Liverpool on January 28 in the s.s. *Mentor* (Blue Funnel Line). It is hoped by May to have the instruments ready for observation; the apparatus taken weighed 4 tons, including the 13-in. astrographic equatorial, which will be used for stellar photometry, to connect the magnitude scales of the northern and southern hemispheres, in addition to the eclipse programme, which is simply a repetition of the testing of the Einstein light-shift. The stars are fainter than those of the 1919 eclipse, but the replacement of the cœlostat by an equatorial should bring a great gain in definition.

The *Times* of January 27 makes the welcome announcement that the Commonwealth Government will put a warship at the disposal of the parties visiting Wollal, Western Australia; these include a large party from the Lick Observatory, also parties from Toronto and New Zealand and some Australian astronomers. This will be of great assistance to the parties, but will not remove all their difficulties, as there is no harbour in the neighbourhood, and ships have to anchor some miles out, and land passengers and goods by boats through a surf that is often heavy.

Mr. J. Evershed, director of Kodaikanal Observatory, hopes to observe the eclipse from the Maldive Islands.

The Pleiades.—Lick Obs. Bull. No. 333 contains an important study of this cluster by Mr. Robert Trumpler. The stars belonging to it are distinguished from the background stars by their proper motion; Boss's value for the bright stars is 5·4″ per century in position angle 157·9°. A list is given of 246 stars, of magnitudes between 2·8 and 15·2, that are concluded to be members of the cluster; this conclusion is supported in the case of the fainter stars by the fact that the average motion of stars of these magnitudes is much smaller. The conclusion is strengthened by an examination of spectral types; these are found directly for the stars brighter than magnitude 11, and inferred from the colour-index for the fainter ones. On plotting spectral class against magnitude a smooth curve is found, which descends less steeply in the middle portion than at the ends; it is interesting to note that a practically identical curve was reached at Greenwich by Messrs. Davidson and Martin on plotting effective wave-length against spectral type for stars in the Greenwich astrographic zone.

Inferring the absolute magnitudes for each spectral type from stars of known parallax, the parallax 0·008″ is found for the Pleiades. The hypothetical parallax deduced from the binaries in the cluster is 0·010″, while Hertzsprung and Hartmann found 0·014″ from the parallactic motion of the group. It is inferred that the round value of 100 parsecs, or 320 light-years, is close to the true distance. One very interesting fact is that the red and yellow stars in the cluster are dwarfs, the only giants being those of type B and perhaps a few of type A. It will be remembered that on Russell's theory the B type is the latest of the giant stages, so that the cluster would seem to be in its old age. Examination of the binary stars supports Aitken's conclusion that stars of considerable mass are more likely to divide. Another point noted is the deficiency of stars of type F, suggesting that this may be a short-lived stage. The average star density of the whole group is about ten times that in the sun's neighbourhood. That in the centre of the group is still greater. Correcting for the sun's motion, the speed of the group is 9 km./sec.

Chemistry at the British Association.

THE attendance at Section B during the Edinburgh meeting of the British Association was exceptionally large, and was well maintained throughout, so that, although the meeting-place of the section was the commodious chemistry lecture-room of the University, it was sometimes impossible to find accommodation for all those who wished to hear the discussions. The joint meetings with other sections were very popular, and the practice adopted by the section in recent years of having only a small number of papers at each session led to the interest in the proceedings being well maintained owing to the full discussion of important papers.

The programme contained a number of contributions to the subject of chemistry in its bearing on the problems of animal and vegetable life. The joint discussion with the Section of Physiology on oxidations in living tissues has already been reported (Nature, November 10, 1921, p. 353). The president's address on "The Laboratory of the Living Organism" (Nature, October 20, 1921, p. 243) was one of the most successful features of the meeting. Dr. Forster omitted the more technical portions of his printed address, and delivered an exceptionally lucid lecture which must have made clear to many students of chemistry who had not previously studied recent work in biochemistry both the importance of the subject and the fascinating character of the reactions which take place at atmospheric temperatures and without the presence of energetic condensing agents in the living organism. The paper by Prof. Robinson, which followed on the presidential address, elaborated one aspect of the same subject, the author indicating the reactions by means of which flavones, anthocyans, and other compounds which occur naturally as plant pigments may be derived from carbohydrates by condensations which are capable of occurring at the atmospheric temperature.

Profs. Baly and Heilbron and Mr. Barker dealt with the synthesis of formaldehyde and carbohydrates from carbon dioxide and water under the influence of light. These reactions are brought about by light of very short wave-length, but in the presence of certain coloured substances, which act as photo-catalysts, they can take place in light of a lower frequency. Chlorophyll, on account of its optical properties, is an ideal photo-catalyst for both stages of the carbohydrate synthesis. Dr. E. J. Russell pointed out that although magnesium is an essential constituent of chlorophyll, the addition of magnesium salts to the soil does not increase the amount of photo-synthesis in plants, as does the addition of that of potassium salts. He also remarked that the first product of carbohydrate synthesis in the plant is cane-sugar, which is then hydrolysed. The formaldehyde hypothesis, proposed fifty years ago by von Baeyer, is thus still a matter of controversy. A paper by Prof. Jaeger, of Groningen, had to be taken as read on account of the time occupied by the preceding discussions. In this the author showed that the decomposition of simple organic acids and their salts in solution by ultra-violet light was in a high degree dependent on the presence of catalysts, the results thus having a bearing on the question of photo-synthesis.

Another group of papers dealt with physical chemistry. The discussion on the structure of molecules, held jointly with Section A, was highly successful, and has already been reported (Nature, October 13, 1921, p. 218). Theories of atomic structure, which have hitherto been the special concern of the physicist, are now invoked to explain chemical phenomena, especially those connected with valency; hence the new interest taken by chemists in the subject. Three papers on surface tension were also communicated to the section. Prof. Jaeger described the experimental methods by which he has been able to measure the surface tension of liquids between the temperatures of $-80°$ and $+1625°$ C. The method consists in determining the pressure needed to cause a gas bubble to burst when emerging from a platinum capillary immersed to a known depth in the liquid. The results obtained from molten salts indicate that if Eötvös's relations be assumed to hold, these liquids must be highly associated, but that the validity of the assumption is doubtful. The method is not applicable to metals, as it is necessary that the liquid should wet the platinum. Mr. Cosmo Johns described his observations on the surface of freely flowing liquid steel. The optical properties of such a surface indicate that it is free from oxide, and the author has previously explained this fact as being due to an atmosphere of iron vapour. Evidence for such an atmosphere was now given, the particles collected from the atmosphere near to the outlet of the furnace being relatively richer in manganese (the more volatile metal). The behaviour of these fine particles under the influence of gravity and of a magnetic field was also described. Prof. Desch gave an account of measurements of foam cells in soap and other foams. The most frequently occurring figure proved to be the pentagonal dodecahedron, slightly distorted. An examination of the crystal grains of several metals proved that these grains had the form of foam cells, graphs showing the frequency of occurrence of similar faces coinciding completely, from which the conclusion was drawn that the grain boundaries are determined by surface tension.

A question of national interest was raised by the paper on the modern dye industry contributed by Prof. H. E. Fierz, of Zürich. The main argument of the paper was that the capacity for production of dyes now largely exceeded the demand, and that it was impossible for the dye industry to remain self-contained. The intermediate and final products lent themselves readily to conversion into pharmaceutical and photographic chemicals, technical colloids (viscose, bakelite, etc.), and similar products. The chemical industry must therefore be regarded as a whole, and a new organisation was necessary.

A discussion on atmospheric pollution by smoke concluded the session. Dr. Owens described the apparatus used by the Advisory Committee, and showed records taken at various stations in London, whilst Mr. W. Thomson described the somewhat different apparatus used in Manchester, and exhibited a long series of records from that town. The principal difference noticed was the regular occurrence of a weekly maximum on Monday in the smoke pollution of Manchester, which was never observed in London. That the clearness of the atmosphere during the coal dispute of 1921 was due to the absence of smoke, and not merely to the exceptionally fine weather, was proved by comparing the sunshine records from different parts of the same town. The report of the Fuel Economy Committee, which had a bearing on the same subject, was received, but was not discussed by the section.

The sittings for the reading and discussion of

papers were confined to the mornings, but the section was also occupied in the afternoons. Prof. Barger gave a demonstration in the University of methods for the micro-analysis of compounds containing carbon, hydrogen, and nitrogen, whilst other afternoons were devoted to excursions. Much interest was taken by members in the inspection of the new University chemical laboratories at Liberton, which are arranged as single-story buildings with a central store, the arrangement being convenient and economical, whilst allowing the greatest possible freedom when alterations have to be made. Other visits included the Heriot-Watt College, Messrs. Younger's brewery, the North-British Rubber Co.'s mills, Pumpherstone Oil Works, and the pharmaceutical works of Messrs. Duncan, Flockhart and Co. The rubber works and the shale oil works proved to be specially attractive to members.

Rehtia, the Venetic Goddess of Healing.

AT a meeting of the Royal Anthropological Institute held on January 11 Mr. J. Whatmough read a paper on "Rehtia, the Venetic Goddess of Healing." The Venetic goddess Rehtia (or, as her name might have appeared in Latin, *Rectia*), for whom an apt Greek parallel in name and functions, as well as in characteristic votive offerings, has been found in the Spartan Artemis Orthia, was worshipped not far from the modern town of Este (15 miles south-west of Padua). Her cult, known perhaps to a handful of scholars all told, bears, according to Mr. Whatmough's new explanation of an important group of her offerings, a close likeness to that of the Italic Juno as the protecting goddess of women, with whom Rehtia should be compared rather than, as previously, with the Etruscan Nortia. The group of inscribed votive offerings in question—the so-called "nails" and "wedges"—now better regarded as pins with pendant axe-shaped talismans of a well-known Hallstatt type, was made all but exclusively by women, as the dedicatory inscriptions show. From the shrine of Orthia at Sparta come large numbers of bronze pins, comparable with the Venetic pins which, it is suggested, were given, originally at all events, by women as votive offerings before (or just after) childbirth.

Just as Orthia is expressly described as "The Restorer," or as a healing deity who "restored women to health after childbirth and preserved their infants" (and as such was associated at Epidaurus with Asclepius *Orthios*), so Rehtia is called *Sanatis*, "the Healer," and the word *akeo* which appears on another class of her votive offerings seems also to refer to her healing functions (compare Greek ἀκέομαι). Women paying their vows to Juno Lucina at Rome had to loosen all knots and fastenings about their clothing and take down their hair; it would then be appropriate for them to offer their dress- and hair-pins (or votive objects copied from these) to the goddess. The miniature talismanic axes would imply a magical purpose, the safeguarding of mother and child during gestation and after delivery. With *Sanatis* and *akeo* we can compare such epithets of Juno as Lucina, Februa (Sanatis especially in this connection), Fluonia, and Sospes. It would be a simple step in the development of the goddess (as of Juno) for her to become the saving goddess of both sexes and all classes. The chief duty, however, within her purview would be to maintain or to restore physical health—the soundness, fitness, *rightness* of the body.

Livy, describing events which occurred in 302 B.C. (nearly a century before the beginning of the romanisation of Transpadane Gaul), refers to a temple in the country of the Veneti not far from Padua which he ascribes to Juno; Strabo calls it a temple of the Argive Hera. Most probably the ancient Veneti worshipped a great goddess Rehtia whose functions were similar to those of the Italic Juno and the Argive Hera, so that later observers like Livy and Strabo, familiar with both the more famous Roman and Greek cults, noted the similarities between these and the Venetic cult, and regarded them as essentially the same, if, indeed, we are not further to conclude that with the extension of Greek and Roman religions and civilisations an actual identification had taken place.

Mr. Peake, in discussing Mr. Whatmough's theory, agreed that the bronze objects were not "nails" and "wedges," but pins, though possibly cloak-pins rather than hair-pins, and "axes." The use of the long cloak-pin in the Iron age, when for practical purposes the pin had developed into the fibula, was possibly to be explained by religious conservatism. He also suggested that possibly the wedge-shaped "axe" talisman had developed from the anthropomorphic form of talisman rather than the latter from the former. A third possibility was that they were merely ornaments made to jingle, similar to those common among all horse-loving peoples such as were the invaders of Italy from the north in the Late Bronze and Early Iron ages. While Rehtia could doubtless be equated with Orthia and with Juno, question arose whether the cult was Mediterranean. The Argive Hera is markedly Mediterranean, but Orthia belongs definitely to the northern peoples, as probably did Rehtia. No doubt there had been amalgamation, but the more distinctive features were northern. In their culture some things point to the Veneti being northerners, and probably they were one of the waves of immigration, evidence of the earliest of which was found at Bologna.

British Mycology.

THE Transactions for 1920 of the British Mycological Society published in July last are evidence of the increasing activities of the group of botanists whose work is amongst the fungi. The presidential address by Mr. Petch deals with fungi parasitic on scale-insects, and includes an historical account of the growth of knowledge since the first record of a fungus growing parasitically on a scale-insect was made by Desmazières in 1848 at Caen, in Normandy. The list is now a long one, and will doubtless be further extended; and though the majority of scale-insect fungi are tropical, there is some work to be done on them in the British Isles. In the tropics enormous destruction of scale-insects is effected by these fungi, and, as some of the scale-insects are serious pests of economic plants, the suggestion naturally arose that the pests might be controlled by means of the entomogenous fungi. A special investigation was undertaken by the United States Bureau of Entomology in Florida, but the results agree with those of other experiments, and Mr. Petch affirms that after thirty years' trial there is no instance of the successful control of any

insect by means of fungus-parasites. Prof. A. H. R. Buller describes the mechanism by means of which the common mould-fungus, Pilobolus, is able to shoot its spore-case, containing many thousands of spores, a distance of several feet. Sunlight striking obliquely on the protoplasm of the cell beneath the spore-case gives rise to a stimulus resulting in a movement which places the axis of the stalk on which the spore-case is borne in the line of the light-ray. The fungus may be described as having an optical sense-organ or simple eye which it uses for laying its gun in a definite direction. Pilobolus lives in fields on the dung of herbivorous animals, and by directing its guns towards the source of brightest light is enabled to shoot its sporangia into open spaces on to grass and other herbage. Herbivorous animals eat grass and sporangia together, and the spores are passed unharmed in the solid excreta in which they germinate.

Mr. F. T. Brooks discusses the inheritance of disease-resistance in plants in the light of recent Mendelian work. It has been shown that susceptibility and immunity to yellow rust disease among varieties of wheat are genetic factors operating in a Mendelian way, and Mr. Brooks suggests that resistance and susceptibility of potatoes to wart disease may afford a similar case. He points out, however, that we are very much in the dark as to what is the essential factor conferring resistance, and the possibility that changed conditions of environment may break down to some extent the resistance-powers of the host as regards certain diseases. There are also short papers of local interest and on new or rare British species. Mr. Ramsbottom explains the "Californian bees," the identity of which has been puzzling folk during the past two years. The organism is the well-known ginger-beer plant which was investigated by the late Prof. Marshall Ward, and consists of two organisms, a yeast and a bacterium, living in symbiosis and causing alcoholic fermentation in a sugary solution.

University and Educational Intelligence.

CAMBRIDGE.—A special Syndicate appointed to consider possible alterations in the regulations for the Mathematical and Natural Sciences Tripos with the object of facilitating the acquisition by candidates in one subject of a knowledge of the other has reported in favour of the addition of mathematics to the list of subjects for the Natural Sciences Tripos, Part I. Arrangements are proposed by which part of the papers set in the Mathematical Tripos, Part I., may be used as papers in the Natural Sciences Tripos, Part I. The reform will be of considerable assistance to students reading physics, physical chemistry, and chemistry.

LONDON.—The Senate has received with great satisfaction a communication from the executors of the late Sir Ratan Tata intimating their continuance for a further period of five years of his benefaction of 1400*l.* a year to the Ratan Tata Foundation. This will henceforth be administered as a distinct department by the London School of Economics.

The following doctorates have been conferred:—*D.Sc.* (*Economics*): Mr. T. E. G. Gregory, an internal student, of the London School of Economics, for a thesis entitled "Tariffs: A Study in Method." *D.Sc.* (*Chemistry*): Mr. S. C. Bradford, an external student, for a thesis entitled "On the Theory of Gels," and other papers; and Mr. E. B. Maxted, an external student, for a thesis entitled "The Influence of Inhibitants on the Occlusion and Activation of Hydrogen by Palladium and Platinum," and other papers.

MANCHESTER.—The executors of the late Mr. Hermann Woolley, who was for many years treasurer of the University, have given a donation of 1000*l.* towards the endowment of a lectureship in pharmaceutics.

The following appointments have been made:—Reader in geography, Mr. W. H. Barker, of University College, Southampton; assistant lecturer in physics, Mr. W. S. Vernon; and assistant lecturer in chemistry (technology), Mrs. M. B. Craven.

OXFORD.—The Romanes lecture for 1922 will be delivered at 6 p.m. on May 24 in the Sheldonian Theatre by Prof. A. S. Eddington, Plumian professor of astronomy at Cambridge and president of the Royal Astronomical Society. The subject will be "The Theory of Relativity and its Influence on Scientific Thought."

On January 31 Congregation rejected by 65 votes to 62 the preamble of a statute by which it was proposed to discontinue the Delegacy of the University Museum, and to establish in its place a Board consisting of the heads of the departments of natural science in the University. The opinion of the teachers of science was divided on the question, some, both of the professors and of the college tutors, being opposed to the change. It is, however, probable that there is an almost general conviction that the present constitution of the Delegacy is capable of amendment, though the particular scheme of reform proposed by the Council did not commend itself to the majority. The statute was introduced by the Rev. G. B. Cronshaw, fellow of Queen's, and was supported by Sir C. S. Sherrington and Prof. W. H. Perkin and by the president of Magdalen. It was opposed by Mr. H. B. Hartley, fellow of Balliol, and by Mr. N. V. Sidgwick, fellow of Lincoln.

FIELD-MARSHAL LORD HAIG has been elected Chancellor of the University of St. Andrews in succession to the late Lord Balfour of Burleigh. Lord Haig was elected Rector of the University in 1917, and the office of Chancellor, to which he has now succeeded, is held for life.

ON Wednesday, February 8, at the Sir John Cass Technical Institute, Aldgate, E.C., Prof. W. Rothenstein, principal of the Royal College of Art, will distribute the prizes and certificates gained by the students during the past session and give an address on "Education and Industry."

TWO Theresa Seessel research fellowships at Yale University are being offered, the object of which is the promotion of original research in biological studies. Applications for the fellowships, which are each of the value of 300*l.*, should be made to the Dean of the Graduate School, New Haven, Conn., U.S.A., before May 1 next, accompanied by reprints of scientific publications, letters of recommendation, and a statement as to the particular problem which the candidate expects to investigate.

IT is announced in the *British Medical Journal* that three Canadian universities—Toronto, Western, and Queen's—are co-operating with the Ontario Medical Association in a scheme similar to that adopted by the University of Bristol to keep medical practitioners in outlying districts in touch with recent developments in medicine by means of extension courses. The province has been divided into ten sections, and at a central point in each it has been arranged to hold various courses and give lectures covering a period of six weeks in each year. The courses have already commenced and have proved very popular, many practitioners travelling hundreds of miles to attend them.

Calendar of Industrial Pioneers.

February 2, 1876. Evan Leigh died.—The author of many improvements in cotton machinery and the writer of "The Science of Modern Cotton Spinning" (1871), Leigh was also known as one of the earliest advocates of twin-screw propellers for steamships.

February 2, 1906. Samuel Cunliffe Lister, first Baron Masham, died.—A worsted spinner and manufacturer, Lister took out more than 150 patents, among them being his wool-combing machines and his method of utilising silk waste. The wool-combing machine of the 'fifties cheapened cloth, advanced Bradford's prosperity, and created the Australian wool trade, while by his second great invention he converted what was regarded as useless into a valuable and beautiful material. He was raised to the peerage in 1891.

February 2, 1913. Carl Gustav Patrik de Laval died.—Born at Blosenberg, Sweden, in 1845, de Laval graduated at Upsala University, engaged in practical work, and in 1875 became engineer to the Klosterverken Iron Works. A year or two later he brought out his cream separator, an apparatus now in use throughout the world. Turning his attention to the invention of a steam turbine, he first applied the use of diverging nozzles, discs rotating at a great velocity, and high-speed tooth-gearing. In 1897 he exhibited a turbine supplied with steam at 1500 lb. pressure.

February 3, 1893. James Edward Henry Gordon died.—An original investigator, Gordon worked in Maxwell's laboratory at Cambridge, and in 1880 published "A Physical Treatise on Electricity and Magnetism." He afterwards became connected with some of the pioneer electrical installations in London.

February 4, 1882. Sir William Palliser died.—While an undergraduate at Cambridge Palliser began his study of rifled ordnance and projectiles, and afterwards, when in the Army, became known for his invention of a method of converting smooth bores into rifled guns and his introduction of chilled cast-iron shot.

February 4, 1884. George Auguste Leschot died.—An eminent Swiss horologist, Leschot was one of the first to introduce machinery for making the parts of watches and to make such parts interchangeable. He was also the first to propose the use of the black diamonds of Brazil for the boring of rocks, and with another Geneva mechanician made the first diamond-pointed drill.

February 6, 1877. George Parry died.—Though commencing life as a grocer's assistant, Parry studied the chemistry of iron manufacture, and in 1848 became chemist to the Ebbw Vale Works, where he worked at the utilisation of waste gases, tried Nasmyth's idea of puddling with steam, and made many early experiments in connection with the Bessemer process.

February 7, 1866. David Elder died.—One of the earliest builders of marine steam engines, Elder in 1821 became manager to Robert Napier at Camlachie. He introduced many improvements in his engines, and was one of the first to use steam expansively.

February 7, 1879. Bennet Woodcroft died.—The son of a Lancashire merchant and a pupil of Dalton, Woodcroft became a silk and muslin manufacturer and made valuable improvements in looms and patented various forms of screw propellers. From 1847 to 1851 he was professor of machinery in University College, London, and on the passing of the important Patents Act of 1852 became superintendent of patent specifications. In 1864 he became Clerk to the Commissioners of Patents. He was mainly responsible for starting the Patent Office Library and the Patent Office Museum. E. C. S.

Societies and Academies.

LONDON.

Royal Society, January 26.—Sir Charles Sherrington, president, in the chair.—W. A. **Bone**, A. R. **Pearson**, E. **Sinkinson**, and W. E. **Stockings**: Researches on the chemistry of coal. Pt. 2: The resinic constituents and coking propensities of coals. Prolonged extraction of eight selected coals by typical resin-solvents in a Soxhlet apparatus has no appreciable effect upon their coking propensities, which therefore cannot be ascribed to the presence of free resins. A resin isolated by a new method from two typical bituminous coals has a molecular weight of about 450, agreeing with the empirical formula $C_{31}H_{32}O_3$; its properties correspond with those of a resene in Tschirch's classification of resins. The usual pyridine-chloroform method of extracting coals does not effect a complete separation between the resinous constituents and the degradation products of the cellulose of which coal is conglomerated. It yields an admixture of resins with a predominance of non-resinous substances of cellulosic origin, provisionally designated "humic" bodies. These substances may amount to 4 per cent. of the coal substance. The strong coking propensities of some coals are principally due to the presence, or formation in them by heat, of such non-resinous "humic" substances of cellulosic origin the fusion temperatures of which are below those at which they undergo rapid decomposition; the more complex substances of cellulosic origin, which form the main portion of the coal substance and decompose without fusion, have little or no influence upon the coking properties.—J. A. **Crowther** and B. J. **Schonland**: The scattering of β-rays. The scattering of a homogeneous beam of β-rays has been measured for various elements, and at various angles with the beam. The results obtained are compared with the nuclear theory of scattering of Sir Ernest Rutherford, a correction being applied to allow for the variation of the mass of the β-particle with velocity. Scattering is due to single encounters between the β-particle and the deflecting particles as postulated by the theory until the thickness of the scattering material reduces the radiation to half value. The scattering by gold is in numerical agreement with the theory when measured at very small angles with the primary beam. It increases rapidly as the angle is increased, and finally attains a value approximately four times that given by the theory. This high value is given by the lighter elements at all the angles investigated. Present theories of scattering require modification when the collisions between the β-particle and the deflecting nucleus are closer than a certain critical distance which is of the order of 10^{-10} cm. in the case of gold.—Ann C. **Davies**: The minimum electron energies associated with the excitation of the spectra of helium. The lines of the orthohelium and parhelium series are simultaneously excited when ionisation of the helium atom has occurred. The limiting voltages for excitation are 20·4 and 25·2, according to whether ionisation by multiple impacts can occur or not. The corresponding voltages in the case of the enhanced line $\lambda 4686$ are 54·2 and 80·0 respectively. This line can also be excited from the helium positive ion without further ionisation of the atom at 50·8 volts, the value deduced from Bohr's theory. The minimum voltage for the appearance of the helium band spectrum is 20·4, and the conditions indicate that it is emitted by He_2 molecules. Orthohelium and parhelium lines and the band spectrum are maintained as the voltage is backed down to 13 volts at high pressures.—C. N. **Hinshelwood**, H. **Hartley**, and

B. **Topley**: The influence of temperature on two alternative modes of decomposition of formic acid. Formic-acid vapour in contact with glass surfaces between 200° and 300° C. decomposes mainly in the following ways:—

$$(a)\ H{\cdot}COOH=CO_2+H_2$$
$$(b)\ H{\cdot}COOH=CO+H_2O.$$

The two modes of decomposition proceed at approximately equal rates, but the critical energies calculated from the temperature-coefficients of the respective velocity constants are so different that one reaction should predominate almost entirely unless a phase restriction is introduced. In this case molecules with the necessary critical internal energy do not react at once unless they are in a certain phase.—C. V. **Raman**: The molecular scattering of light in water and the colour of the sea.

Geological Society, January 4.—Dr. G. T. Prior, vice-president, in the chair.—W. D. **Lang**, L. F. **Spath**, and W. A. **Richardson**: Shales-with-beef, a sequence in the Lower Lias of the Dorset coast. Pt. 1: Stratigraphical, by W. D. Lang. The shales-with-beef lie between Table Ledge below and the Birchi Bed above, and consist of an upper 30 ft. of brownish paper-shales with selenite, "beef," and limestone-nodules and lenticles; and a lower 40 ft. of bluish conchoidal marls with indurated marl-beds, beef, and limestone-nodules and lenticles. The main palæontological divisions were given. Pt. 2: Notes on the ammonites, by L. F. Spath. The genera of ammonites found in the shales-with-beef are recorded, and remarks made on their classification and phylogeny. Pt. 3: Petrological Notes, by W. A. Richardson. During sedimentation, calcium carbonate gradually accumulated in solution in the water-logged deposit, and a system of limestones and calcareous nodules was precipitated rhythmically during the initial stages of desiccation. Later, veins of fibrous calcite were deposited at levels of low pressure. On the final drying of the deposit the remaining solutions of calcium carbonate were ultimately deposited as a cementing material.

Optical Society, January 12.—Mr. R. S. Whipple, president, in the chair.—C. J. **Peddle**: The manufacture of optical glass. The history of the manufacture of optical glass can be divided into four epochs, Guinand's discovery of the stirring process in 1796, the work of Abbe and Schott about 1882, and the development in England during the great war being the outstanding features in this history. The method of manufacture is practically the same at the present time as in Guinand's day, any improvement being one of degree rather than of kind. For successful production of the various types the effects of composition upon density, refractive index, melting properties, durability, freedom from colour, and devitrification tendencies have to be studied upon a small scale and the results translated into terms suitable for works practice.—J. W. **French**: The Barr and Stroud 100-ft. self-contained base range-finder. This range-finder has a new type of triple field. It is carried upon a mounting comprising two trucks running upon a roller path of 50 ft. diameter, the trucks being connected by a rigid horizontal framework. Upon the trucks are carried cantilevers, from the ends of which are suspended cradles having special bearings within which the range-finder rests. Training is done by power or by hand. During extensive tests the uncertainty of observation at a range of 31,000 metres did not exceed 20 metres.—T. **Smith**: The optical three-apertures problem. In such an instrument as a submarine periscope, where broad beams of light have to be transmitted down a long tube from a wide field, the relation between the length and diameter of the tube and the number of lenses is considered. Various types of construction are indicated, together with the relative advantages offered by them.

SHEFFIELD.

Society of Glass Technology, January 18.—Dr. M. W. Travers, president, in the chair.—W. L. **Baillie**: An examination and extension of Zulkowski's theory of the relation between the composition and durability of glass. Zulkowski's theory assumes that the essential reactions involved in the founding of glass are the formation of simple silicates of the alkalies and alkaline earths which combine to form double silicates. In these reactions the bases are regarded as competing equally for the acids, and it is assumed that all the materials of the batch enter completely into reaction. If one type of base be molecularly in excess, simple silicates remain in the glass, and are regarded as the prime cause of instability. The difference between Zulkowski's original theory and that now proposed is essentially in the different quantities deduced for the number of molecules of simple silicates present. The term "basic excess" is replaced by a more complete function, for which the term "reactivity coefficient" is suggested. Glasses of satisfactory resistance have reactivity coefficients of under three units. Negative values were generally associated with the most stable glasses, though very large negative values are probably undesirable.—W. E. S. **Turner**: A critical note on the methods of determining the durability of glass. The method of stating the loss in weight due to the attack of reagents is not a trustworthy check. It is better, where possible, to determine either the amount of alkali liberated or the total weight of matter extracted. With boiling reagents flasks gave different results from beakers, and results differed according to the weight or volume of the reagent they contained; pieces immersed gave results different from those obtained where one surface only was in contact with the reagent. Four modes of testing were discussed:—(a) The static method with flasks and beakers, (b) the use of slabs and discs immersed in the reagent, (c) the autoclave test, and (d) a rapid method by grinding glass to pass mesh 20–30. The autoclave test was regarded as uncertain. For speed and convenience test (d) was advocated.—Miss C. M. M. **Muirhead** and W. E. S. **Turner**: The effect of magnesia on the durability of glass. Lime and magnesia glasses were compared. Resistance to attack by water was determined from tests on glass crushed to mesh 20–30 and boiled for one hour. The amount of sodium oxide set free was greater in the case of the lime glasses than in the case of the magnesia glasses. The results of tests on boiling discs in hydrochloric acid for six hours showed that a glass containing small amounts of magnesia was more resistant than the corresponding lime glass, but the difference between the resistance of the glasses is small when they contain 8 or more per cent. of lime or magnesia. Magnesia glasses are less resistant than lime glasses to attack by both sodium carbonate and caustic soda after boiling for three hours.

PARIS.

Academy of Sciences, January 16.—M. Emile Bertin in the chair.—The president announced the death of M. Ciamician, foreign associate.—F. E. **Fournier**: The relations between the form of the hull of a ship, the relative displacements of its satellite wave, its aptitude for speed, its most economical speed, and the resistance of the water to its translation.—C. **Guichard**: The Ω_{00} networks.—P. **Montel**: An exten-

sion of a theorem of M. Landau.—M. **Auric**: The generalisation of complex integral numbers.—M. **d'Ocagne**: The reduction of the fourth dimension to a plane representation.—G. **Tzitzéica**: Networks of points.—P. **Salet**: The pressures of the atmospheres of the stars and the sun. The iron lines of the types *a*, *b*, *c*, *d* of Gale and Adams being unequally displaced towards the red by the effect of pressure, and this displacement being sensibly proportional to the pressure, it is possible, measuring only the difference of displacement of lines of different types, to determine the pressure of the medium in which the lines are produced. The spectra of Procyon, Arcturus, and the sun have been studied from this point of view, and it has been found that the pressures of the atmospheres of the two stars are very slightly higher (1 to 2 atmospheres) than that of the sun. The pressure of the reversing layer of the sun would appear to be only some tenths of an atmosphere.—E. **Brylinski**: An interpretation of Michelson's experiment.—H. **Chaumat**: The application of the ballistic galvanometer to the testing of iron.—G. **Claude**: The accidents observed in the synthesis of ammonia by hyperpressures and on the means of avoiding them.—M. **Taffin**: Annealing and the mechanical properties of glass. The phenomenon of annealing of glass would appear to be only a viscous deformation under the action of internal stresses.—P. **Woog**: The velocity of extension of thin layers of oil on the surface of a sheet of water. From experiments on mineral and fatty oils a connection is traced between the velocity of extension of the oil film on water and the acidity, carboxyl groups of the glycerides, double linkages, and viscosity.—A. **Kling** and Mme. A. **Lassieur**: An apparatus for the determination of the concentration of a solution in hydrogen ions. Application to the detection of mineral acids in vinegar. A compensation method dispensing with the usual standard cell and capillary electrometer and making use of a millivoltmeter.—E. **Grandmougin**: Diphenylsulphone. Considerable quantities of diphenylsulphone, formed as a by-product during the sulphonation of benzine, were accumulated during the war. The author gives an account of some derivatives made with a view to their possible utilisation in the dye industry.—P. **Lemay** and L. **Jaloustre**: Some oxydasic properties of thorium-X. Thorium-X acts as a powerful catalyst in the oxidation of adrenaline and of morphine; on the other hand, no oxidation of the alcohols of the fatty series could be proved.—M. **Muguet**: Lead in the uranium minerals of Madagascar. In the course of the extraction of radium from the Madagascar mineral betafite, lead has been isolated in quantities representing about 0·6 per cent. of the mineral treated. This lead probably arises from the atomic disintegration of uranium; its radioactivity has increased regularly for six months.—M. **Leriche**: Vestiges of the Lutetian in the Quaternary of the north of France.—C. **Jacob**: The structure of north Annam to the north of Thanh Hoa.—L. **Joleaud**: The age of the calcium phosphate deposits of southern Morocco, Algeria, and Tunis.—H. **Joly** and N. **Laux**: The fauna of the middle and upper layers of the Aalenian of the Grand Duchy of Luxemburg.—A. **Boutaric**: The diurnal radiation of the atmosphere at Mont Blanc.—C. **Dufour**: Values of the magnetic elements at the Val-Joyeux station at Villepreux (Seine-et-Oise) on January 1, 1922.—M. **Bridel**: The presence of a glucoside giving rise to an essential oil in the stems and roots of *Sedum telephium*. The glucoside extracted from this plant hydrolysed with emulsin gives glucose and an essential oil smelling of roses. Hydrolysed with dilute sulphuric acid the essential oil undergoes a change, and the smell resembles eucalyptol or terpineol.—A. **Goris** and H. **Deluard**: The influence of solar radiation on the culture of belladonna and the formation of alkaloids in the leaves. Insolation favours the production of alkaloids in the leaves of belladonna, and also the size of the leaves.—C. **Oberthür** and C. **Houlbert**: Some new views on the classification of the Melanargia (Lepidoptera: Satyridæ).—C. **Champy**: The determination of the sexual characters in Tritons. A criticism of some views expressed by Bouin and Ancel.—B. **Roussy**: Measurement of the cutaneous surface of the horse.—M. **Marage**: Acuteness of hearing and aptitude for military service. Deafness alone should not be a cause of rejection for army service, a person entirely deaf being still capable of rendering service to the army in a suitable position.—J. **Dragoui**: The influence of osmotic pressure on cell division.—S. **Metalnikow**: Sterile death in infected caterpillars. Under certain conditions the phagocytes are successful in removing all the foreign organisms (cholera, sarcina, staphylococcus), but the caterpillar dies, although sterile.—M. **Schein**: The possible duality of aphthous fever.—H. **Vallée** and H. **Carré**: Anti-aphthous immunity.

BRUSSELS.

Royal Academy of Sciences, January 7.—M. Aug. Lameere in the chair.—H. **Lonay**: Contribution to the study of the relations and structure of the different parts of the ovule and of its general nutrition before and after impregnation.—P. **Bruylants**: Contribution to the study of the reaction of the organo-magnesium compounds on nitriles.

WASHINGTON, D.C.

National Academy of Sciences, Proceedings, vol. 7, No. 1 (January, 1921).—A. **Van Maanen**: Internal motion in the spiral nebula Messier 33. It is shown that the motion is along the arms of the spiral and is not a rotation of the nebula as a whole. The magnitude of the motions would indicate that the nebula is not comparable in dimensions with the galactic system.—L. B. **Loeb**: The attachment of electrons to neutral molecules in air. The mechanism of negative-ion formation in air lies in the electron attaching itself to the molecule to form the negative ion on the average in one out of 250,000 molecular impacts. It is to the oxygen molecule that the electron is attached.—F. G. **Benedict**, M. F. **Hendry**, and M. L. **Baker**: The basal metabolism of girls twelve to seventeen years of age. The basal heat production per kilogram of body-weight per twenty-four hours decreases regularly with increasing age from 30 Calories at twelve years to nearly 22 Calories at seventeen years.—R. A. **Millikan** and I. G. **Barber**: The reflection and re-emission of electrons from metal surfaces and a method of measuring the ionising potential of such surfaces. Contrary to current belief, there appears to be no such phenomenon as the direct reflection of an electron from a copper surface.—E. H. **Morris**: Chronology of the San Juan area. The establishment of a chronological scale for the area of San Juan gives us a succession of cultural periods during the greater part of the prehistoric period for the south-west.—W. **Bowie**: Some geologic conclusions from geodetic data. Geodetic evidence indicates that land masses are in isostatic equilibrium and that the equilibrium exists in a comparatively small area. It is inferred that land masses have been in equilibrium in former geologic periods, and that mountain systems formed in previous sedimentary areas are due to expansion of the material under them.—D. P. **Smith**: Experiments on the electrical conduction of a hydrogen alloy. The temporary supple-

mentary conduction exhibited by metals during the cathodic occlusion of hydrogen is not of ordinary metallic character.—J. A. **Harris** and E. W. **Sinnott**: The vascular anatomy of normal and variant seedlings of *Phaseolus vulgaris*. A comparative and biometric study of the gross vascular anatomy of the seedlings.—L. L. **Woodruff**: The present status of the long-continued pedigree culture of *Paramecium aurelia* at Yale University. The culture has attained to about 8900 generations during thirteen and a half years of life. Conjugation is not necessary, but there is a periodic endomyxis.

No. 2 (February, 1921).—A. J. **Dempster**: Positive-ray analysis of magnesium. Isotopes of weights 24, 25, and 26 combined in the ratio 1 : 1 : 6 are found.—C. **Barus**: The energy content of the diapason.—W. A. **Setchell**, T. H. **Goodspeed**, and R. E. **Clausen**: A preliminary note on the results of crossing certain varieties of *Nicotiana Tabacum*. One general result has been a demonstration of the difference from a genetic point of view between any two of a number of so-called fundamental varieties of *N. Tabacum*.—J. **Kendall**: The correlation of compound formation, ionisation, and solubility in solutions: Outline of a modified ionisation theory. It is assumed that ionisation is preceded by combination between solvent and solute, and is indeed a consequence of such combination.—E. H. **Hall**: The Peltier effect. Application of the author's recently proposed theories of electrical conduction on metals to the discussion of the Peltier effect.—J. H. **McDonald**: The roots of Bessel's functions.

Official Publications Received.

Bulletin of the American Museum of Natural History. Vol. 44, Art. 20: The Birds of the American Museum of Natural History's Asiatic Zoological Expedition of 1916-1917. By Outram Bangs. Pp. 575-612. (New York City.)

National Research Council. Organisation and Members, 1921-1922. Pp. 55. (Washington, D.C.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-Verbaux des Réunions. Vol. 27. Procès-Verbaux (Juillet, 1921.) Pp. 91. (Copenhague: Andr. F. Høst et Fils.)

Report of the Canadian Arctic Expedition, 1913-18. Vol. 3: Insects. Part K: Insect Life on the Western Arctic Coast of America. By F. Johansen. Pp. 62. (Ottawa.)

Canada. Department of Mines: Mines Branch. The Production of Coal and Coke in Canada during the Calendar Year 1920. Pp. iv+36. (Ottawa.)

The Institution of Civil Engineers. Engineering Abstracts from Current Periodical Literature. Supplement to the Minutes of Proceedings of the Institution. New Series, No. 10, January. Pp. 228. (London: The Institution of Civil Engineers.)

Anales del Museo Nacional de Historia Natural de Buenos Aires. Tome 30. Pp. viii+559+22 plates+maps. (Buenos Aires.)

República Argentina. Ministerio de Agricultura de la Nación: Oficina Meteorologica Naciónal. Boletin Mensual Año 4, Numero 1. Enero de 1919. Pp. 51+maps. (Buenos Aires.)

Agricultural Research Institute, Pusa. Bulletin No. 120: The Serum Simultaneous Method of Inoculation against Rinderpest. By W. A. Pool. Pp. ii+7. 2 annas. Bulletin No. 121: Notes on Contagious Abortion in Pony and Donkey Mares. By R. Branford and T. M. Doyle. Pp. ii+12. 5 annas (Calcutta: Government Printing Office.)

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert and the Secretary, Sugar Bureau). 1920-21. Pp. iv+90+10 plates. (Calcutta: Government Printing Office.) Rupees 1.8.

Communications from the Physical Laboratory of the University of Leiden. Supplement No. 44 to Nos. 157-168. Pp. 74. (Leiden.)

Department of Agriculture, Ceylon. Bulletin No. 48: Summary of Laws and Regulations in Force in Ceylon in Respect of Plant Pests and Diseases. Pp. 6. 50 cents. Bulletin No. 49: The Cultivation of Limes. By G. G. Auchinleck. Pp. 18+2 plates. 50 cents. Bulletin No. 50. The Cultivation of Pineapples in Ceylon. By F. A. Stockdale. Pp. 12+4 plates. 50 cents. (Peradeniya: Department of Agriculture.)

Ceylon Administration Reports for 1920. IV.: Education, Science, and Art. Department of Agriculture: Report of the Director of Agriculture for 1920. Pp. 38. (Peradeniya: Department of Agriculture.)

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 6, No. 2. September. 1s. 3d. Nos. 4 and 5, October. 2s. 9d. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.)

Diary of Societies.

THURSDAY, FEBRUARY 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Napier Shaw: Droughts and Floods (1).

ROYAL SOCIETY, at 4.30.—C. Shearer: The Oxidation Processes of the Echinoderm Egg during Fertilisation.—J. Schmidt: The Breeding Places of the Eel.—J. Gray: The Mechanism of Ciliary Movement.—J. Gray: The Mechanism of Ciliary Movement. Parts 1 and 2.—J. S Huxley and L. T. Hogben: Experiments on Amphibian Metamorphosis and Pigment Responses in Relation to Internal Secretions.

LINNEAN SOCIETY OF LONDON, at 5.—F. Johanssen: The Canadian Arctic Expedition.—Dr. J. C. Willis and U. Yule: Some Statistics of Evolution and Distribution in Plants and Animals, and their Significance.—Mrs. E. M. Reid: Note on Fossil Floras.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.—Sir William Hale-White, Sir William Willcox, Sir Berkeley Moynihan, and Mr. Sherren: Discussion: The Treatment of Gastric Ulcer.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—L. J Romero and J. B. Palmer: The Interconnection of A.C. Power Stations.

CHEMICAL SOCIETY, at 8.—E. J. Hartung: The Action of Light on Silver Bromide.—C. K. Ingold: The Structure of the Benzine Nucleus. Part I. Intra-nuclear Tautomerism.—C. K. Ingold: The Structure of the Benzine Nucleus. Part II. Synthetic Formation of the Bridged Modification of the Nucleus.—C. K. Ingold and H. A. Piggott: The Structure of the Benzine Nucleus. Part III. The Suppression of Intra-nuclear Change.

FRIDAY, FEBRUARY 3.

INSTITUTE OF COST AND WORKS ACCOUNTANTS (at Holborn Restaurant), at 2.30.—Costing Conference on the Necessity for Scientific Costing.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. K. M. Walker: The Nature and Cause of Old Age Enlargement of the Prostate (Hunterian Lecture).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—H. S. Denny and N. V. S. Knibbs: Some Observations on a Producer-gas Power Plant.

EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.—Prof. H. J. Fleure: Some Social Bearings of Race Study.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—Major W. Gregson: Utilisation of Waste Heat from Internal Combustion Engines.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. A. L. Flemming and others: Discussion: The Uses and Limitations of N_2O and O_2 Anæsthesia.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Francis Younghusband: The Mount Everest Expedition.

MONDAY, FEBRUARY 6.

VICTORIA INSTITUTE (at 1 Central Buildings, Westminster, S.W.1), at 4.30.—Dr. A. T. Schofield: Some Difficulties of Evolution.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. H. Todd: Orthopædic Aspects of Rheumatoid Arthritis (Hunterian Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—T. J. Gueritte: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—J. Joseph and others: Discussion: Some Practical Applications of the Thermionic Valve.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.1), at 8.—A. H. Hannay: Standards and Principles in Art.

ROYAL SOCIETY OF ARTS, at 8.—C. Ainsworth Mitchell: Inks (Cantor Lectures) (3).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.

SURVEYORS' INSTITUTION, at 8.—Adjourned Discussion on paper by W. R. Davidge: The Problems of Greater London.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—President's Address to Students.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Brig.-Gen. G. K. Cockerill: Byways in Hunza and Chitral.

TUESDAY, FEBRUARY 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Variable Stars (2), Long Period Variables.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—W. Turnbull: The Timbers of British Columbia.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions made to the Society's Menagerie during the months of November and December, 1921.—A. H. Evans: Some Deductions from a Set of Cuckoo's Eggs taken near Cambridge, and now Exhibited.—Lord Clifford of Chudleigh: *Nototherium mitchelli*.—Miss L. E. Cheesman: (1) Sense-organs of the Fresh-water Crab, *Cardisoma armatum*. (2) Position and Function of the Siphon in the Amphibious Mollusc, *Ampullaria vermiformis*.—C. W. Hobley: The Fauna of East Africa and its Future.—Dr. J. Stephenson: Contribution to the Morphology, Classification, and Zoogeography of Indian Oligochæta.—IV. The Diffuse Production of Sexual Cells in a Species of *Chaetogaster* (Fam. Naididæ). V. *Drawida japonica* (Michlsn.), a Contribution to the Anatomy of the Moniligastridæ. VI. The Relationships of the Genera of Moniligastridæ; with Some Considerations on the Origin of Terrestrial Oligochæta.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Dr. H. F. Parshall: Hydro-electric Installations of the Barcelona Traction, Light, and Power Company.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—O. J. Wilkinson: The Application of Flashlight Photography to the Study of Natural History Subjects.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—W. H. Wilson: A New High-tension Generator for X-ray and other work.—H. C. Head: Canny Ryall Diathermy Apparatus; Ionostat; A New Iontoquantimeter; New X-ray Protective Material.—H. E. Donithorne: The Taylor Jones Electrostatic Oscillograph; A New Design of Gold Leaf Electroscope.—C. Andrews: A New Boiling-water X-ray Tube.—F. R. Butt and Co., Ltd.: Diathermy Apparatus.—E. E. Burnside: A New Model of X-ray Table.

WEDNESDAY, FEBRUARY 8.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. G. T. Fisher: A Research into the Pathology and Ætiology of Osteo-arthritis, with Observations upon the Principles underlying its Treatment (Hunterian Lecture).

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—E. L. Bass: Engine Lubrication.

ROYAL SOCIETY OF ARTS, at 8.—E. V. Evans: Some Solved and Unsolved Problems in Gas Works Chemistry.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 9.—Sir Leonard Rogers: Amœbic Liver Abscess: Its Pathology, Prevention, and Cure (Lettsomian Lectures) (2).

THURSDAY, FEBRUARY 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Napier Shaw: Droughts and Floods (2).

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Sir J. A. Ewing: The Atomic Process in Ferro-magnetic Induction.—Prof J. W. Nicholson: Problems relating to a Thin Plane Annulus.—Prof. T. H. Havelock: The Effect of Shallow Water on Wave Resistance.—R. H. Fowler and S. N. H. Lock: The Aerodynamics of a Spinning Shell. Part II.—F. P. Pidduck: The Kinetic Theory of a Special Type of Rigid Molecule.—J. E. Jones: The Velocity Distribution Function and the Stresses in a Non-uniform Rarefied Monatomic Gas.—H. Bateman: The Numerical Solution of Linear Integral Equations.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—H. Hilton: Conics on the Pseudo-sphere.—W. F. D. MacMahon: The Theory of Closed Repeating Polygons in Euclidean Space of Two Dimensions.—G. H. Hardy and J. E. Littlewood: Dirichlet's Series with a Barrier of Singularities.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—E. J. Kingston-McCloughry: The Design of Modern Water-turbines.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Annual General Meeting.—F. W. Preston: The Structure of Abraded Glass Surfaces.—A. J. Dalladay and F. Twyman: The Stress Conditions Surrounding a Diamond Cut in Glass.—Lt.-Col. J. W. Gifford: A Supplementary Note on Achromatic One-Radius Doublet Eyepieces.—F. Twyman and A. J. Dalladay: Change in Refractive Index at the Surfaces of Glass Melts.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Sir Ernest Rutherford: Artificial Disintegration of Elements.

INSTITUTE OF METALS (London Section) (at Sir John Cass Technical Institute, Jewry Street, E.C.3), at 8.—R. T. Rolfe: Gun-metal.

FRIDAY, FEBRUARY 10.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Annual General Meeting.—Dr. E. A. Owen and Bertha Naylor: The Measurement of the Radium Content of Sealed Metal Tubes.—Sir William Bragg: The Crystal Structure of Ice.—Dr. K. Grant: A Method of Exciting Vibrations in Plates, Membranes, etc., Based on Bernouilli's Principle.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Anniversary Meeting.

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NATURE

THURSDAY, FEBRUARY 9, 1922.

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British Water Power and its Administration.

FOLLOWING almost immediately upon the publication of the Third and Final Report of the Water Power Committee of the Conjoint Board of Scientific Societies, there has recently appeared the Final Report of the Water Power Resources Committee of the Board of Trade. To a certain extent it may be said that the two Reports cover common ground, but there is this important distinction, that, whereas the Water Power Committee of the Conjoint Board addressed itself to the widest possible survey of the resources of the British Empire, the Board of Trade Committee has been limited by its terms of reference to the resources of the United Kingdom. The investigations, therefore, of the latter body within this restricted area have naturally been more searching and more detailed, and to that extent more complete.

The Report of the Board of Trade Committee confirms, in general, the views which were expressed in a leading article in NATURE of December 8 last in reviewing the earlier Report, particularly as regards the necessity of conserving the national resources of water power, of taking steps without delay to ascertain accurately their full extent and availability, and of providing effectively for their economic and judicious development in the interests of industrial enterprise. The Committee states, as a result of its researches, that it is estimated by the development of certain specified water-power schemes in Great Britain (a by no means exhaustive list) that a continuous output of 210,000 kilowatts could be obtained at an economic rate, and that this would result in a saving in coal consumption for steam-raising purposes of nearly three million tons per annum.

The statement is impressive as an instance of the prodigality with which the country's power resources are allowed to run to waste. But while the desirability of effecting so appreciable a reduction in the national coal bill must be clear and unmistakable to all who give a thought to the matter and realise the limitations of our stores of solid fuel, yet the suggestion put forward in the present Report as to the primary step to be taken towards this end will perhaps not receive such unquestioning assent. The Committee, with two dissentients, recommends the establishment by Act of Parliament of a Water Commission with controlling powers over the water resources of England and Wales, and authority to compile proper records, to allocate supplies, to adjust conflicting interests, and to recommend suitable development schemes. The public, restive after a long and irksome imposition of bureaucratic control, will, we feel, be inclined to express sympathy with the minority view of Mr. Sandford Fawcett and Mr. W. A. Tait that the appointment of such a Commission is unnecessary, and that it must necessarily prove a source of further expense to the taxpayer. Mr. Tait, in his separate memorandum on the proposal, utters a justifiable warning on the inherent defects of a permanent official body vested with statutory powers. "Such a Commission," he says, "however well constituted and however open-minded its members at first may be, will inevitably in course of time become bureaucratic in its outlook, and will in this respect be less fitted to adapt itself to circumstances, as these vary from time to time, than independent Committees of Parliament, who, from the nature of things, approach any subject with fresh minds and unbiased views."

We confess that, to a considerable extent, we share Mr. Tait's apprehensions. There is undoubtedly a tendency on the part of all official bodies to become stereotyped and perfunctory. Imbued with a sense of immunity from criticism, they not infrequently adopt autocratic methods, and this does not endear them to the public mind. For our own part, while cordially agreeing as to the urgent desirability of carrying out each and all of the functions and duties enumerated for the proposed Commission, we are inclined to suggest that the collection and col-

lation of data could be assigned at less expense to some existing department, such as the Ordnance Survey, as is the case in the United States, where the work is carried out by the Geological Survey, and that as regards jurisdiction and oversight of sources of supply these could be exercised without undue strain by County Councils or similar provincial bodies, while sanction for new schemes in the public interest should be obtained by application to Parliament in the customary way by private Bill as at present. We see no occasion for departmental initiative in industrial enterprise. Such a policy leads to the preparation of grandiose and untimely projects like that recently put forward for the River Severn by the Ministry of Transport. British commercial enterprise is not dead, and if a scheme be reasonably practicable and remunerative it is sure to receive support. We therefore range ourselves alongside Mr. Fawcett and Mr. Tait in deprecating the creation of an additional Government department with a retinue of salaried officials. There is a significant suggestion in the Report that the expenses of the proposed Commission should be defrayed *in part* by a levy on water undertakings in England and Wales. We imagine that this will give rise to some demur.

Into the more detailed recommendations of the Committee we do not feel it necessary to enter at the moment. The Report is a lengthy one, running to 165 foolscap pages, with maps and diagrams. In addition to the primary and principal recommendation, upon which we have commented above, there are subsidiary recommendations, such as that all hydrometric data collected in the United Kingdom should be compiled on a uniform basis (a schema is exhibited in an appendix), and that the widest publicity should be given to the information obtained in these surveys. With both these suggestions we are in complete accord. There is also the interesting statement that, "leaving out of account the question of availability, the schemes in our possession relate to potential water-power of a total capacity in excess of 250,000 kw. (continuous). The aggregate power involved in the various parts of Great Britain is as follows: Scotland, 194,965 kw.; Wales, 35,900 kw.; England, 20,440 kw. The Irish Sub-Committee estimates that the total available potential water-power resources of Ireland amount to 280,000 kw. (continuous)."

The purview of the Report is comprehensive and includes a consideration of tidal power, canals, salmon fisheries, pollution of underground water, and land drainage. We do not propose to discuss these features. Our immediate object will be achieved if we succeed in focusing attention on the urgent necessity for a systematic compilation of the water resources of the country and of the Empire, to be followed by some means of ensuring a judicious application of the available power in the most economical manner so as to reduce the present excessive demands on our reserves of solid fuel.

American Organic Chemicals.

THE production of synthetic organic chemicals for use in research is being developed in America on the same lines as in this country. Laboratories have been specially equipped for the purpose by the Eastman Kodak Company, which makes a number of compounds and purifies others yielded by the chemical industry of the country. In that way some eleven hundred different chemicals are at present available. Although this is only half the number of substances offered by one of the English manufacturers, the effort is meeting with enthusiastic support from men of science in America, and those concerned feel thereby greatly helped and encouraged. In that country, at least, the war-time resolution of independence in the matter of scientific supplies is not forgotten.

Much complaint is made in this country concerning the prices of such chemicals. It is therefore of interest to compare Kahlbaum's pre-war prices and the present prices of a well-known English manufacturer with those of the Eastman Kodak Company. A comparison extending to four pages of the Eastman list gives the ratio: Kahlbaum, 100; B.D.H., 135; Eastman, 171—not so great an increase on pre-war prices as the increase in cost of labour would lead one to expect.

In a paper read before the Society of Chemical Industry last August, C. E. K. Mees and H. T. Clarke gave some account of the chemical work of the Eastman Company. They said it had been conducted hitherto at a very considerable loss, the first year's working showing a deficit of about 3000*l.*, although no rent or overhead charges were debited. This loss was generously borne by the company.

If American users and producers continue to work in the same spirit, not only will they gain the immense advantage of national independence in the matter of organic chemicals, but also the business will become self-supporting and in the end remunerative. At the same time, laboratories in which such organic compounds are made should provide a useful training-ground for young technical chemists.

Elie Metchnikoff.

Life of Elie Metchnikoff, 1845–1916. By Olga Metchnikoff. Authorised translation from the French. Pp. xxiii + 297. (London: Constable and Co., Ltd., 1921.) 21*s*. net.

In an introductory chapter Madame Metchnikoff relates how, some years ago, one who scarcely knew her husband had asked permission to write his biography. Metchnikoff wanted his biography written, for he held that the story of the evolution of a mind and character in relation with its environment, if faithfully set down by one knowing and comprehending, is always an interesting psychological document. The idea of the story of his life being related by one who neither knew nor understood was, however, repugnant to him. So it came about that Madame Metchnikoff undertook the biography of her husband with his co-operation and on the understanding that the whole was to be told without reservation. The result, as Sir Ray Lankester observes in an appreciative preface to the English edition, is "a remarkable and beautiful record of the development and activities of a great discoverer."

Metchnikoff was born in 1845 in the province of Kharkoff, where he was educated first at the lycée and then at the university. The lycée is represented as a progressive school, and the sketch of the youthful Metchnikoff and his companions affords an interesting glimpse of the intellectual awakening of young Russia at this period. Among the books he read at fourteen years of age was Buckle's "History of Civilisation," and we gather from the biography that the idea of the dependence of human progress upon science originated from reading that work. This belief became strengthened as he grew older, and ultimately it reached the intensity of a religious faith. At fifteen years of age Metchnikoff abandoned the religion in which he had been brought up, and so ardently preached atheism to his fellow-pupils that he received the nickname "God is not." Although he appears to have devoted most of his time at school to reading books on science, religion, and philosophy, he nevertheless passed out from the lycée with the highest honours and entered the university. This is described as a stagnant and reactionary institution. His teachers were uninspiring, and exerted little influence upon him.

While at the university, however, he read "The Origin of Species," which he had brought back with him from a visit to Germany. Metchnikoff was fascinated by the splendour of the horizon it opened, and considered it had more influence upon his later career than any other book he read. He seems to have planned to devote himself to searching for further support of Darwin's great generalisation. With this object he decided to undertake the study of intermediate types with a view to disclosing the genetic relationships between different orders of animals.

This programme could not be carried out at his own university, so as soon as his undergraduate career was completed he went to Germany. Afterwards he removed to Naples, where he met Kowalevsky. Both young men became engaged in a comparative study of the embryology of invertebrates. Metchnikoff discovered embryonic layers similar to those of vertebrates in Arthropoda and Cephalopoda, thus helping to bridge the gap between the higher and lower animals.

It was at Giessen in 1865 that intracellular digestion by the cells of the alimentary canal of a land-planarian (*Geodesmus bilineatus*) was observed. It is explained that this was the first time that he had encountered this phenomenon except in protozoa and very simple metazoa. He was much impressed, and afterwards regarded the observation as the basis of his phagocytic theory, although at the time its full significance was not appreciated.

Returning to Russia full of enthusiasm for science, Metchnikoff was appointed a *docent* at Odessa, but, finding the university backward and reactionary, he removed to St. Petersburg, where he hoped to find conditions for work more congenial. He was, however, disappointed. There was no laboratory for him to work in, his time was consumed by teaching for a subsistence, his eyes became troublesome and his health bad. He was lonely, and during an illness he was nursed by a young lady in the house of a mutual friend. Craving for affection and sympathy, he not unnaturally became engaged to be married.

Unfortunately, the lady was phthisical and developed alarming symptoms immediately after marriage. The next few years are described as a tragic struggle against disease and poverty. The serious affection of his eyes prevented the use of the microscope, and his young wife's health became so precarious that he was obliged to resign his appointment and take her to Madeira, where she died.

After his wife's death Metchnikoff started on the return journey to Russia in blank despair, and, seeing no issue to his situation, attempted suicide at Geneva. Fortunately, he took too large a dose of morphia, was violently sick, and recovered.

On his return to Russia Metchnikoff was appointed to the chair of zoology at Odessa, which he occupied for nine years. He threw himself with enthusiasm into the duties of his post. At Odessa

he met Madame Metchnikoff, who was then a schoolgirl. Finding that she was interested in zoology, he undertook to teach her, and shortly after they married. His second marriage was a happy one; his wife, although more directly interested in art than in science, became a willing disciple. Madame Metchnikoff thus describes their work together:—

"It was both delightful and profitable to work with him, for he opened out his ideas unreservedly and made one share his enthusiasm and his interest in investigations; he could create an atmosphere of intimate union in the search for truth which allowed the humblest worker to feel himself a collaborator in an exalted task."

Metchnikoff appears to have exerted a great influence in the university, especially upon the young men, but was regarded with some suspicion by the authorities, owing to the independence of his ideas and the directness with which they were expressed. After the assassination of Alexander II. in 1881 the government of the university became more and more reactionary, and the independence of the university was threatened. Though not greatly interested in politics, Metchnikoff seems to have become unavoidably involved in these quarrels, and ultimately, finding the conditions intolerable, resigned.

His resignation of the Odessa chair and the circumstances which led to it preyed upon his mind. Another period of ill-health ensued associated with intense depression, during which suicide was again attempted. In order not to harrow his family by a suicide that was too obvious, and at the same time to put the occasion to the use of ascertaining whether relapsing fever could be transmitted by inoculation, he injected into himself some blood from a patient suffering from that disease. He had a prolonged attack of the fever, but this shock treatment cured his pessimism, and after his recovery he had a renascence of vital energy such as he had not enjoyed for years. Moreover, thanks to the inheritance of landed property, the Metchnikoffs were now in a position of modest independence and able to live where they liked. Accordingly in 1882 they repaired to Messina to take advantage of the opportunities for study afforded by the sea fauna of the Mediterranean.

It was at Messina, at Christmas of that year, that what Metchnikoff regarded as the great event of his scientific life occurred. It is described by him in his own words as follows:—

"One day, when the whole family had gone to a circus, I remained alone with my microscope, observing the life in the mobile cells of a transparent starfish larva, when a new thought suddenly flashed across my brain. It struck me that similar cells might serve in the defence of the organism against intruders. I felt so excited that I began striding up and down the room, and even went to the seashore to collect my thoughts.

"I said to myself that, if my supposition was true, a splinter introduced into the body of a starfish larva, devoid of blood-vessels or of a nervous system, should soon be surrounded by mobile cells, as is to be observed in a man who runs a splinter into his finger. This was no sooner said than done.

. . . . .

"I fetched some rose-thorns and introduced them under the skin of some beautiful starfish larvæ as transparent as water.

"I was too excited to sleep that night in the expectation of the result of my experiment, and very early the next morning I ascertained that it had fully succeeded.

"That experiment formed the basis of the phagocyte theory, to the development of which I devoted the next twenty-five years of my life.

. . . .

"A zoologist until then, I suddenly became a pathologist."

It appears that the discovery of phagocytosis first disclosed to him the possibility of utilising his talents to intervene advantageously in human affairs. A moral purpose in life was found, and thenceforth Metchnikoff became an optimist and a scientific philanthropist. His future researches, although conducted in the laboratory, were essentially directed towards the improvement of the health and happiness of mankind. Possibly his scientific work suffered occasionally from his impatience to apply results to the benefit of his fellow-creatures, for, like most philanthropists, he exhibited some intolerance of criticism of his efforts.

In 1882 phagocytosis as a curative force was still only an hypothesis, but an opportunity for putting it to the test of experiment soon occurred. Water fleas (Daphniæ) were observed to be subject to infection by a fungus (*Monospora bicuspidata*) the spores of which, sharp like needles, traversed the gut of the insect when introduced with food. Watching the process in these transparent creatures, Metchnikoff saw that, immediately after the entrance of a spore into the body cavity, it was attacked by mobile phagocytes and englobed. If the phagocytes succeeded in digesting all the spores, the daphnia recovered, otherwise the spores germinated, and the fungus, spreading throughout the body, killed the insect. Recovery or death depended upon the issue of the battle.

The next question to be decided was whether this method of defence was common to all animals. That some diseases of higher animals were attributable to invasion by microbes had recently been established, and it is explained how Metchnikoff's previous training and experience as a zoologist had led to the conviction of the essential unity of structural plan and physiological behaviour throughout

the animal kingdom. Metchnikoff was convinced that in the case of such a fundamental mechanism as that he had discovered in invertebrates this would prove to be true, and shortly afterwards he succeeded in establishing the generality of the phenomenon by experiments upon higher animals infected with the anthrax bacillus. In this case the bacilli were attacked and eaten by the white blood corpuscles which wander everywhere. Two other observations recorded deserve special mention because they opened up new country, the exploration of which occupied Metchnikoff and his pupils and many others for the next twenty years.

The first of these was that active phagocytosis occurred only in animals refractory to anthrax, thus providing a possible interpretation of the natural immunity of some species of animals to a disease. The second was that animals naturally sensitive to anthrax could be induced to respond like naturally refractory ones by vaccination, an indication of the nature of acquired immunity.

Such entirely new conceptions were not readily acquiesced in, and even encountered hostility. Two great men, Virchow and Pasteur, however, were immediately impressed by them, and in 1888 the latter invited Metchnikoff to come to the Pasteur Institute. The invitation was accepted, and there he remained until the end of his life, occupied under ideal conditions in developing the consequences of his discovery at Messina.

At the Pasteur Institute he found every facility for his researches, and was undisturbed by administrative or academic work. He enjoyed the companionship of wise colleagues, themselves actively engaged in inquiries in bacteriology and pathology, and soon became surrounded by willing pupils ready to undertake investigations dictated by his fertile imagination.

This was a time of immense activity, mainly devoted to exploring the whole subject of immunity which he had illuminated by the discovery of phagocytosis. This prolific period of his career is skilfully dealt with in broad outline, and details which, being of a highly technical character, would be tiresome to the general reader are omitted. The theories current regarding immunity when Metchnikoff approached the subject from a naturalist's point of view are briefly sketched, and the influence of his work and that of others in the development of our present views is indicated.

In 1900 Metchnikoff presented an account of his researches to the International Congress of Medicine at Paris, and fought his critics for the last time. Then, convinced that his deductions were sound, he proceeded to expound his views at length under the title, "Immunity in Infectious Diseases," which appeared a few years later.

Metchnikoff's greatest scientific achievement was undoubtedly the discovery of phagocytosis and its manifold significance in biology and pathology, and it is clearly brought out in his biography that he would not have made these discoveries had it not been for his previous training and research in zoology. Perhaps the best way to appraise this, his contribution to science, is to try to think what our present knowledge of inflammation and immunity would be without it.

At the age of fifty-three Metchnikoff turned his attention to the subject of senility. Regarded from a long biological view, man's imperious instinct for life in the later years of existence, notwithstanding obvious breakdowns, must, he considered, be a pathological coincidence. How, otherwise, was the fear of death, a general and inevitable occurrence, to be explained? Metchnikoff imagined that this lack of harmony exists because senility is premature and partial and arrives before the natural instinct for death has had time to develop.

If this supposition were correct, the greatest of life's disharmonies might be remedied, for he believed that it was within the power of science not only to preserve the body from the depredations of disease, but also to maintain the equilibrium of the tissues. In such a case happiness and contentment should be the lot of man for a period far exceeding the usually allotted span. Upon such ideal physiological existence or "orthobiosis" a quiet satiety with living should, he supposed, ultimately supervene and death be welcomed as sleep at the end of a long day.

The consideration of the changes in the tissues in old age led Metchnikoff to the conclusion that, apart from the damage done by diseases such as syphilis, tuberculosis, and other chronic infections, the principal cause of premature degeneration of the important cell elements was a prolonged intoxication by the products of the activities of the innumerable bacteria which inhabit the large intestine. For this hypothesis he obtained anatomical and experimental support.

The former he tersely summarised by the phrase, "the longer the large intestine, the shorter the life," an aphorism which is to some extent responsible for the depredations of some of our famous surgeons.

Having arrived at the conviction that unlicensed bacterial activity in the colon was harmful, Metchnikoff essayed to control it by implanting into the alimentary canal a special microbe which produced much lactic acid from carbohydrates, and was itself

capable of surviving in high concentration of this acid. To this end he recommended, and himself practised, the imbibition of large quantities of soured milk.

Metchnikoff's preoccupation with the disadvantages of senility have been misunderstood and misinterpreted. Although his attention was becoming unpleasantly directed in his own person to the effects of a life of intense activity and mental excitement, coupled with serious cardiac mischief, it is not to be ascribed to the morbid introspection of an invalid. Old age is a legitimate subject for scientific inquiry. It is not unnatural, but unfortunate, that nobody becomes sufficiently interested in the problems of senility until their own age well-nigh precludes the possibility of a successful enterprise. It was approached by Metchnikoff with ideas based on broad biological principles, and most of his late work was really concerned to find justification for them.

Elie Metchnikoff's enthusiasm for his theory of orthobiosis was maintained actually until the end of his life, and the last chapter of the biography contains many records of his mental attitude on contemplating death at short range. He was anxious that these should be recorded as so few with the capacity to analyse their mental processes retain their intellectual powers until the end of life.

His wishes have been piously complied with, and his observations, when confronted with impending dissolution, are faithfully recorded as his final contribution to his theory of the development of the death instinct.

The book is more than an account of the interesting discoveries of Elie Metchnikoff and their far-reaching importance in natural history; it is a human document, an account of the mental adventure of a striking personality, with contemporary science as a setting, told with a *naïveté* reminiscent of Marie Bashkirtseff.

The translation is excellent, and little if any of the charm of the original French is lost. The biography contains as frontispiece a characteristic picture of Metchnikoff in his laboratory, and concludes with a useful bibliography of all his published writings.

Electrical Measurements.

Absolute Measurements in Electricity and Magnetism. By Prof. A. Gray. Second edition, rewritten and enlarged. Pp. xix+837. (London: Macmillan and Co., Ltd., 1921.) 42*s.* net.

ALL physicists are familiar with the first edition of this important work, which, completed in 1893, has long been regarded and used as a standard treatise on electrical measurements. In introducing the second edition Prof. Gray refers at the outset to a certain lack of interest shown by physicists at the present time in the theory and practice of absolute measurements, and it is undoubtedly the case that, in our universities at any rate, the subject receives less attention than was formerly devoted to it. The principal reason for this change may be traced to the nature of such work as the experimental determination of absolute electrical units, and the accurate comparison of secondary standards with them, and also to the great importance which work of this kind possesses. Few, if any, of our university laboratories are sufficiently well equipped for the prosecution of researches in which the construction of apparatus and the carrying out of measurements of the highest precision are involved; and so necessary is this work recognised to be that special laboratories, such as the National Physical Laboratory in this country, and the Bureau of Standards at Washington, have been established, at which it can be more effectively organised and carried out, and at which the research worker in any of the universities may have his measuring instruments accurately standardised. Thus the apparent decline of general interest among physicists in methods of absolute measurement is not due to any diminution in the importance of the subject, but to the fact that the practice of these methods is now more concentrated in institutions specially equipped for the purpose.

A second reason for the change may be found, as suggested by Prof. Gray, in the fact that new and fascinating subjects of study, mainly consequent upon the discovery of the X-rays and radio-activity, have arisen which have been taken up with enthusiasm in our universities, and have to some extent diverted attention from absolute measurements of the classical kind. While it is of the greatest importance that research into the problems of modern physics should be pursued as vigorously as possible, it is no less important to the future of the science that the endeavour to attain greater accuracy in our standards and methods of measurement should not be relaxed. It may well be that the future trend of physical theories will be largely influenced by the degree of accuracy with which some of the important constants can be determined.

The new edition of Prof. Gray's book will be welcomed as a full and clear statement of the present position regarding accurate electrical measurements. There is probably no other book which contains so full an account of the classical experiments for the determination of electrical units and constants, and the many detailed abstracts of original memoirs give the book a special value as a work of reference.

The principal changes found in the new edition

relate to the calculation of the constants of coils, and the theory of absolute electro-dynamometers and current balances, a domain of the subject to which Prof. Gray has himself so largely contributed. His well-known calculation of the mutual inductance of two single layer coils the axes of which intersect at any angle has led to the realisation of an absolute electro-dynamometer, constructed at the Bureau of Standards, the constant of which can be calculated to a high degree of accuracy. It was shown by Prof. Gray that if the coils of the instrument are concentric and have lengths $\sqrt{3}$ times their radii, all the terms between the first and the seventh vanish in the zonal harmonic series for the mutual inductance and the couple between them, and the remaining terms amount to only a very small correction if the dimensions of the inner coil are small in comparison with those of the outer. Consequently the couple is given very accurately by the first term alone of the series—that is, it can be calculated on the assumption that the inner coil is suspended in a perfectly uniform field equal to the field at the centre of the fixed coil.

It is shown how the values of the mutual inductance of two coaxial single-layer coils (including the important case of a helix and a coaxial circle), the self-inductance of a single-layer coil, and the mutual attraction of two coaxial coils, such as those of a current balance, can also be deduced from the general formula. Many other cases are worked out in the chapter on the calculation of inductances, which is much extended in the new edition, and the description and illustrations of the current balances of the National Physical Laboratory and the Bureau of Standards, and the electro-dynamometer of the latter institution, form a valuable feature of the book.

Other portions of the book which are much expanded are those dealing with magnetometry, measurements in alternating current circuits, the distribution of alternating currents in cylindrical conductors, the comparison of resistances, and the absolute measurement of resistance. The recommendations of the International Conference on Electrical Units held in London in 1908, embodying the definitions of the international ohm, ampere, and volt, and the specification of the Weston normal cell, are given in appendices.

Much that was in the old edition has of necessity been omitted from the new; the omitted portions, however, mainly of a theoretical nature, are not directly connected with methods of measurement, and have been fully treated in Prof. Gray's "Treatise on Magnetism and Electricity." The result is a more complete and a better arranged account of methods of electrical measurement and the calculations connected therewith.

In its new form the book is in one volume, and the larger page, the absence of small type, and the numbered sections will make the book more acceptable to the reader. Typographical errors are remarkably few for a work of this size, and in the few cases where results are stated erroneously (as, for instance, the expression for the capacity of a condenser on p. 749) the reader will find no difficulty in supplying the correction.

Of the great value of the book there can be no question, and it may be confidently anticipated that the new edition will be appreciated as highly as was its predecessor.

E. T. J.

The Art of Prehistoric Man.

Prehistory: A Study of Early Cultures in Europe and the Mediterranean Basin. By M. C. Burkitt. Pp. xx + 438. (Cambridge: At the University Press, 1921.) 35*s*. net.

DURING the last two decades great progress has been made in our knowledge of prehistoric man, especially by discoveries in the caves of France and Spain. Most of the results are published in technical memoirs in serials not easily accessible, and it is difficult to follow them without much previous study and extensive reading. Mr. Burkitt has therefore done good service by the preparation of his volume on "Prehistory," which summarises the whole subject and enables both the student and the general reader to appreciate its present position. He himself has taken an active part in much of the research, in association with the Abbés H. Breuil and H. Obermaier; he thus writes from personal knowledge, and adds sufficient details of some of the most interesting localities to make his text-book a useful guide for those who wish to visit them.

Other English books, especially those of Lyell and Boyd Dawkins, have already given a good general account of the discoveries of early man in the caves of this country, so that Mr. Burkitt has done well in devoting attention chiefly to France and Spain. His "outline of the history of the subject," however, fails to give due credit to the English pioneers, whose systematic work in Brixham Cave, Kent's Hole, and Wookey Hole is not even mentioned. MacEnery and Pengelly are overlooked, and Mello's discovery of the drawing of a horse's head on a piece of bone from the Cresswell caves is wrongly described, thus throwing doubt on its authenticity. On p. 76 bone is said to have been "first utilised in Upper Mousterian times," and when this statement, based on French and Spanish experience, is contradicted on p. 89 by a casual reference to the English discovery of a large bone

implement with early Palæolithic flint implements at Piltdown, the latter is briefly dismissed as "possibly the only exception." England has indeed played a prominent pioneer part in unravelling the problems of prehistoric man, and deserves full acknowledgment.

Mr. Burkitt begins with an excellent concise account of man's relation to the glacial period in western Europe, and shows how far the successive races may be correlated with the mild intervals in this period which are marked by the retreat of the glaciers in the Alps and Pyrenees. He also refers to Baron de Geer's counting of the annual layers of sediment which the ice of the last glacial episode in Scandinavia deposited in the sea during its retreat northwards. From this it is inferred that man cannot have reached southern Scandinavia until it was uncovered twelve thousand years ago. The latest phases farther south in Europe must therefore have been somewhat earlier. How long before the glacial period man first appeared here remains uncertain, but both the Abbé Breuil and Mr. Burkitt are agreed that Mr. Reid Moir's discoveries of worked flints in the Red Crag prove his presence in the Upper Pliocene.

FIG. 1.—Incised drawings rom caves in Dordogne and Cantabria. A. A feline, a bear, and a mammoth engraved on the wall of the cave of Combarelles, Dordogne. B. Head of a deer engraved on the wall of the cave of Castillo, Cantabria, with a similar engraving on a piece of bone from the same cave. C. A hog-maned horse engraved on the wall of the cave of La Pasiega Cantabria. From "Prehistory: A Study of Early Cultures in Europe and the Mediterranean Basin."

Most of the volume is devoted to flint and bone implements and art, and Mr. Burkitt traces the successive developments in a more exhaustive manner than has hitherto been attempted. He classifies the flints, and not only records the order of their succession, but also describes exactly several places of discovery which prove their relative age. He shows how bone harpoons may be treated as fossils, and points out the minute differences which mark the successive periods to which they belong. He also describes palimpsests among the cave-pictures which exhibit the superposition of different styles of art. He is thus prepared to determine the relative age of almost any discovery of prehistoric human handiwork. On the whole the school of "prehistorians" to which he belongs is probably right, but it makes no allowance for sporadic outbursts of genius.

The study of the cave-pictures is especially fascinating, and Mr. Burkitt treats it in great detail. Besides the incised figures on the rock, there are paintings in ochre, oxide of manganese, carbon, and kaolin, all mixed with fat. Those of Palæolithic age are isolated drawings, not grouped in scenes, and the majority are in comparatively inaccessible parts of the caves rather than in ordinary living chambers. They were therefore probably not designed for ornament, but in connection with some ideas of sympathetic magic. "No doubt the wonderful naturalistic animals, sometimes

portrayed with the arrows of a hunter in their sides, formed part of a ritual, and were meant to ensure a successful hunt." The incised sketches on bones found in the earth of the floor of the caves were probably in some cases the preliminary studies for the work on the walls and roof.

The volume is illustrated by forty-seven plates, of which we reproduce one (Fig. 1) showing a selection of incised drawings from the caves of Dordogne and Cantabria. All these plates are well described, but they would have proved more useful if they had been referred to in the text. In this and other respects, indeed, the editing of the volume leaves much to be desired, but the work is a unique addition to the literature of prehistoric archæology, and cannot fail soon to reach a second edition, which will afford an opportunity for some useful revision. A. S. W.

The Science of Ancient Greece.

The Legacy of Greece. Edited by R. W. Livingstone. Pp. xii+424. (Oxford: Clarendon Press, 1921.) 7*s.* 6*d.* net.

THIS book redresses in a remarkable way the injustice done to Ancient Greece in most popular works on the subject. Reference to any short history now in use, such as Bury's, or even to such a fine work as "Hellenica" of the last generation, will show that the author finds "the legacy of Greece" in the city-founding activities of the Greeks, and, above all, in the internecine conflicts of the cities in their prime, with some short reference to the Periclean ideal and the philosophic differences of Plato and Aristotle. There is little about literature, less about art, and nothing at all about science. Mr. Livingstone, in planning this volume, has deliberately and rightly set himself to correct this and to put the really substantive achievement of the Greeks in the realm of thought in its due place. The result is that a good third of the book is given to science, and if we include Prof. Burnet's article on Philosophy, which shows its connection with science, we get a larger proportion still. It is most welcome evidence of a change of mind in the university which stands more than any other among us for Greek studies.

The effect is amazing to those accustomed to the old and mainly political outlook, and it will be very wholesome. We see that in every branch of science, in biology and medicine as much as in mathematics, the Greeks laid the foundations on which mankind has built ever since. Sir T. L. Heath well brings this out in his article on Mathematics and Astronomy, which is a complete review of the Greek work from Thales to Diophantus; while Dr. Singer is equally full on Biology and Medicine. The reader will probably share one impression which was borne in strongly on the present reviewer. The writers who describe the newly admitted branches of the legacy of Greece are so full of their subjects, and so eager to display their richness and wonders, that their essays suffer somewhat in comparison with those which deal more allusively with the more familiar topics. Hence the most readable papers, which leave the clearest impression, are Prof. Burnet's on Philosophy, Mr. Livingstone's on Literature, and Mr. Percy Gardiner's on "The Lamps of Greek Art." These are altogether admirable; the leading features are emphasised, and no attempt is made to be exhaustive.

But the fault—if it be a fault—in the essays on science is entirely in the right direction. We have here for the first time in a compendious form the main steps of the Greek construction in mathematics, astronomy, biology, and medicine, and the book is well worth buying for this part of it alone. A charming essay by Prof. D'Arcy Thompson on the Science of Aristotle adds to the attractiveness of the volume, but somewhat disturbs the balance of Dr. Singer's excellent articles on biology and medicine as a whole.

The supreme merit of the book is that it puts in unmistakable prominence the intellectual quality of the Greek mind in its prime, its desire to know, and its power of arranging the material it acquired in that connected form which we call scientific. This is equally salient on the mathematical and the biological side. Sir T. L. Heath shows us how the Greek philosophers had quite early hit on the fundamental equations in geometry; within the seven hundred years of their flourishing they had founded trigonometry through the necessities of their astronomy, anticipated the integral calculus by their method of exhaustions, and laid the basis of algebra in the first generalised notation of Diophantus. In the sciences of life Aristotle had given the first rational classification of living things and an incomparable mass of faithful and detailed description; while the sound principles of Hippocrates in the fifth century in tracing health and illness to natural causes were far in advance of medical theory and practice until the revival of science a thousand years later. It is by these achievements, more than by any other, that the Greeks still rule us from their tombs, and we are deeply grateful to Mr. Livingstone and his coadjutors for putting them in such a clear light without ignoring the due proportion of political theory, art, and psychological philosophy. The well-chosen illustrations add greatly to the value of the volume. F. S. MARVIN.

Jute and Silk in India.

Imperial Institute. Indian Trade Inquiry: Reports on Jute and Silk. Pp. ix+90. (London: John Murray, 1921.) 5*s*. net.

THESE reports embody the results of the work of special committees, formed, in response to the invitation of the Secretary of State for India to the Imperial Institute Committee, to inquire into the possibilities of further commercial usage of the principal Indian raw materials in the United Kingdom and in other parts of the Empire.

The commercial production of jute is confined to Northern India, including Assam. The fibre is obtained from the inner bark of the stems of two annual plants, *Corchorus capsularis* and *C. olitorius*, members of the family Tiliaceæ, and the crop is raised on small holdings by the Indian ryot. More than 60 per cent. of the total crop is consumed in the Indian jute mills, the remainder being exported to the United Kingdom, various Continental countries, and the United States.

In its recommendations the committee has kept in view two main objects, namely, to make use of our practical monopoly of jute to further the interests of the Empire, and to increase the output, and thereby steady and keep at a moderate level the price of the raw product. It recommends an export duty on raw jute leaving India with a rebate in full to consumers within the Empire, the revenue from the duty to be devoted to the establishment of a scheme for the investigation of problems affecting the production in India of jute and allied fibres. As soon as seed-selection experiments are sufficiently advanced the Government should provide each grower with seed sufficient for the season's crop and adopt means to ensure that none but approved seed is sown. Machinery should be set up to deal with the situation arising from a short crop. The production of Bimli jute (the fibre of *Hibiscus cannabinus*) should be encouraged, and means adopted to improve the condition in which it reaches the market.

The position of India among the silk-producing countries is unduly low; natural advantages are not fully utilised, and, at present, the industry is not able to meet local demands. For many years the mulberry silk industry in India has been steadily declining. The committee recommends the establishment by the Government of India of a central Sericultural Institute, the functions of which should include the training of men to develop sericulture in India, the supply of disease-free "seed" of approved native and foreign races of worms, the testing of new races and the production of hybrid races, and the investigation of silkworm and mulberry diseases. Smaller institutions should be established in all important sericultural districts. The committee considers that the enhanced value of Indian silk that would result from a radical improvement in its quality should render it possible for the Indian product to compete successfully with Japanese and Chinese silks.

Valency and Atomic Structure.

Valenzkräfte und Röntgenspektren: Zwei Aufsätze über das Elektronengebäude des Atoms. By Prof W. Kossel. Pp iv+70. (Berlin: Julius Springer, 1921.) 12 marks.

THE literature on atomic structure has received an interesting addition by the publication of this little work, which consists of two essays, the first being entitled "The Physical Nature of Valency Forces," and the second "The Significance of X-rays in the investigation of Atomic Structure." Berzelius first put forward the theory of the electrical nature of valency forces, but the difficulty of explaining homopolar combination by means of it had led to its being discredited. It has now come to the fore again as the result of our knowledge of the relation between atomic number, the charge on the nucleus of the atom, and the place of the atom in the periodic series, and in its recent developments Kossel has played an important part.

In the first paper, after referring to the various atomic models which have been proposed from time to time, Kossel points out that we can explain many of the chemical properties of the elements if we assume a tendency on the part of the atom to lose or gain electrons, so as to revert to more stable electron configuration. In losing or gaining electrons the atom becomes a charged ion, and without knowing anything further of its structure it is possible to explain the formation of a large number of compounds. The valency forces correspond to an electrostatic field surrounding the ion, such as would arise from a charge placed at the centre of the atom. The molecule as a whole must be electrically neutral, but neutral molecules may have oppositely charged atoms at different points in their structure, and so may attract other neutral molecules with the formation of complex compounds. Kossel makes no attempt to explain the way in which homopolar compounds are formed; he merely indicates the lines along which investigation may be possible. He emphasises the point, however, that the study of organic com-

pounds has led to an excessive importance being attached to valency phenomena in homopolar compounds, whereas a complete theory should cover the very large class of inorganic heteropolar compounds formed by the majority of the elements.

The second essay is a short review of the work which has been done on X-ray spectra and the origin of X-rays, with particular reference to the partitioning of electrons into shells surrounding the nucleus.

The author's style is somewhat involved, and for a reader who is not a good German scholar the argument is sometimes difficult to follow.

Our Bookshelf.

(1) *Abridged Callendar Steam Tables, Centigrade Units.* By Prof. H. L. Callendar. Pp. viii. 1*s.* net.
(2) *Abridged Callendar Steam Tables, Fahrenheit Units.* By Prof. H. L. Callendar. Pp. 8. 1*s.* net.
(3) *Callendar Steam Diagram, Centigrade Units.* 6*d.* net.
(4) *Callendar Steam Diagram, Fahrenheit Units.* 6*d.* net. (London: E. Arnold, n.d.)

THE two sets of abridged tables (1) and (2) will be found to contain all that is required for engineering calculations. Table 1 in each set contains the properties of saturated steam for pressures ranging from 28·98 in. of vacuum up to 535·31 lb. per sq. in. gauge pressure. Table 2 gives the total heat of dry steam (superheated or supersaturated), and table 3 contains the entropy values for dry steam at various degrees of superheat and supersaturation. On the first and last pages will be found notes of the symbols and equations employed. The tables are well arranged and clearly printed, and will be of great service to students and engineers in practice.

(3) The Centigrade steam diagram is also well arranged and has convenient scales. (4) The curves on the Fahrenheit steam diagram are copied from those on the Centigrade diagram; the numerals printed on them are the corresponding Fahrenheit numbers. Hence the scales on the Fahrenheit diagram are not so convenient, and we think it would have been better had this diagram been drawn independently of the Centigrade diagram.

Spot and Arc Welding. By H. A. Hornor. (Griffin's Technological Handbooks.) Pp. vii + 296. (London: Charles Griffin and Co., Ltd., 1920.) 15*s.*

THE application of electric welding processes to heavy steel construction, such as obtains in shipbuilding, forms the main topic of this book. The results of extensive tests conducted during the war in the United States with the object of testing the processes are also given. This work was, unfortunately, discontinued at the time of the armistice, but from the results it was shown that trustworthy electrically welded joints can be made of greater strength than corresponding riveted joints, and that consequently some economy in material can be expected. Special designs for all-welded ships are discussed, and a good deal of interesting information is given on other applications of both spot and arc welding and the training of welders. Small all-welded craft have already been constructed in England, and the author shows that the technical knowledge now available is sufficient for a considerable extension of this method of ship construction.

Handbuch der biologischen Arbeitsmethoden. Edited by Prof. Dr. Emil Abderhalden. Abt. 5, *Methoden zum Studium der Funktionen der einzelnen Organe des tierischen Organismus.* Teil 7, Heft 1, Lieferung 12, *Sinnesorgane.* Pp. 195. (Berlin und Wien: Urban und Schwarzenberg, 1920.) 30 marks.

THE "Handbuch der biologischen Arbeitsmethoden," edited by Prof. Emil Abderhalden, will consist of forty-eight parts, in which chemical, physical, biological, psychological, and many other methods are treated at considerable length. The section under notice, by E. Budde, is devoted to the mathematical theory of audition. The first division of this contains a very full discussion of free and forced small vibrations of a point, followed by systems under non-linear forces, including combination tones. The second division deals with strings and membranes, while the third refers to plane-waves in air. Having thus laid the foundation, the author passes to the detailed treatment of human audition, in which he reviews the interpretations of the phenomena put forward by the chief workers on the subject, but dwells especially on the parts played by the basilar membrane and the endolymph.

Turbines. By A. E. Tompkins. Third edition, entirely revised. Pp. viii + 180. (London: S.P.C.K.; New York: The Macmillan Co., 1921.) 8*s.* net.

THE early part of this book is taken up with historical notes and some explanations of the principles involved in the working of turbines. This is followed by three chapters on water-wheels, turbine pumps, and water turbines. The remainder of the book deals with steam turbines. For the most part the book is descriptive, and the simple language employed, together with the many excellent drawings, will render the volume of interest to the general reader. The author has had considerable experience in the working of turbines, and his treatise on "Marine Engineering" is well known. It is therefore rather surprising to find on p. 21, in reference to a rotating wheel, that "every particle of the wheel also tends to fly away from the axis in a radial direction, due to centrifugal action or force." This statement is somewhat misleading. There are one or two misprints, and the accepted notation for British thermal unit is B.Th.U., not b.t.u.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Antitrades.

THE long series of pilot-balloon ascents made at and near Batavia (lat. 6° 11′ S., long. 106° 50′ E.) during the years 1909–17 has given a fair knowledge of the system of air-currents over West Java up to great heights. The general outcome of this investigation has been communicated to the Royal Academy of Science of Amsterdam.[1] My endeavour to explain that system led to a controversy between Dr. Braak and myself and Prof. van Everdingen.[2] After renewed consideration of the problem I have come to new results which I propose to set out provisionally here.

In the memoir presented to the Amsterdam Academy is inserted a synoptical table containing the mean directions and velocities of the wind for each month and for height-intervals of 1 km. up to a height of 24 km. In it the principal air-currents have been made conspicuous by letter colouring and framing. They are :—

First, the *west monsoon* prevailing during the southern summer in the bottom layers up to 5–6 km.

Above it, up to 10–13 km., blow easterly winds with southern components, which I would call tradelike winds. In the winter season such winds blow in the bottom layers up to 3 km.

Above these tradelike winds blow antitradelike winds, *i.e.* easterly winds with a northern component. Their upper limit reaches to 18 km. from December until March; it goes down to 12 km. in June, and again rises to the maximum height of 21 km. in October. The velocities show two maxima: in February at a height of 15 km. (12 m./sec.) and in August at 14 km. (22 m./sec.): in April they are very weak. Not only is their velocity a maximum, but also the transport of air-mass.

Over the antitradelike current appear again currents of tradelike character; however, from March until September an eastward moving air-mass is embedded in them, reaching heights of 24 km. *in maximo.*[3] Very high balloon flights in March and September revealed the existence of strong (30–40 m./sec.) easterly winds up to 30 km.

Considering these results, three principal questions arise:—(1) Are the tradelike winds real trades? (2) Is the antitradelike current a true deflux from the equator towards the sub-tropics? (3) Whence do the great velocities of the high antitradelike and upper tradelike winds originate?

The currents mostly possess a stationary character, and consequently their directions will be in close agreement with the trend of the isobars in their level. For Java the latter will be conditioned by the neighbourhood of the Australian continent. As in the southern winter over Australia is settled a circular High, we may expect over Java the trend of the isobars to be E.N.E.–W.S.W. and the gradient to be towards the equator. However, by friction with the earth surface the air blows across the isobars and takes an E.S.E.–W.N.W. direction. This means real outflow to the equator; thus the tradelike wind mentioned above is a trade.

In the southern summer over Australia lies a Low, causing the west monsoon, but above this Low the gradient is reversed and a High prevails. This causes in the same manner as mentioned above a tradelike wind. The friction required for it, I presume, is caused by the streaming one over another of the two currents with contrary directions (the west–east below, the east–west above). Thus, I think, the first of the three questions put forward has been answered in the affirmative: the tradelike winds are trades.

As to the second question, we may consider first the southern winter season. In it the gradient Australia–Java is reversed at the level of ±5 km. But does it change too in the other season at 3 km.? Apparently not, because, going upwards, the easterly winds do not then change to westerly ones; they back only from E.S.E. to E.N.E., while the velocity does not vanish. Now, admitting the absence of friction in these layers, and consequently assuming the current to follow the course of the isobars, we come to the conclusion that this course remains mainly the same when going upwards, or the Australian High subsists in these higher layers, though perhaps shifting somewhat to the eastward.

Accepting this, we may ask: Might it be that the antitradelike current flows around the Australian High, bringing about thus the deflux towards the subtropics?

In that case the antitradelike current should be a true antitrade, although of local character. But then we are obliged to admit that a flux towards the equator will also occur at the opposite side of the oval system of the Australian High; only the deflux should surpass it by the mass of air (or part of it) which ascends from the surface in the equatorial belt.

This influx, too, may give us an answer to our third question: What is the cause of the great east–west velocities of antitradelike and upper tradelike winds? Exner[4] points to the fact that ascension of air at the equator is able to increase its east–west velocity only by a fraction, and, therefore, tries to explain the great velocities of high equatorial east winds by shifting of air from higher latitudes towards the equator with preservation of rotational moment. A meridional shift from latitude ±15° causes velocities from 30–40 m./sec.

My result for the antitradelike current over Java is the same as that obtained by Sir Napier Shaw when calculating isobars for the level at 8000 metres.[5] He, too, finds long-stretched Highs, and he speaks of the flowing of air around these Highs, by which the east–west wind velocities of the equator act on the opposite currents of the sub-tropics as by chain-drive pulling.

However, through lack of data Sir Napier Shaw had to calculate his isobars by means of one and the same set of vertical temperature-gradients for the whole hemisphere, which, of course, makes the results somewhat doubtful for the equatorial belt, because there the critical pressure-differences at the 8000-metre level are small only.

For that reason I have sought for another independent way to solve the antitrade problem, and I think I have found it by mapping the average directions of cirrus drift as observed in the equatorial belt.

Cirrus floats there at levels of about 11 km., and

1 Proceedings, April 16, 1918.
2 *Tijdschrift v. h. K. Aardrijkskundig Gen.*, vol. 35, 1918, No. 1, and vol. 36, 1919, No. 4.
3 Owing to a typographical error in the synoptical table the velocities at the levels 18, 19, and 20 km. for June have wrongly been given as 1 m./sec. instead of 10 m./sec.

4 "Dynamische Meteorologie." 1917, p. 182.
5 Rede Lecture. NATURE, July 21, 1921. p. 653. Sir Napier Shaw most kindly provided me recently with a copy of the unpublished *isobaric charts* which he constructed for the northern hemisphere

at that height over Java the antitradelike winds blow from May until October, while during the rest of the year winds with tradelike character prevail.

The mean directions of cirrus drift which were at my disposal (mostly borrowed from H. Hilderbrandson [6]) I plotted separately for winter and summer, and although they are very sparse I made an endeavour to construct lines of flow. The result is incorporated in the accompanying maps (Fig. 1). They should be regarded as a first trial; *e.g.* no attention was given to the density of the lines of flow, only to their direction. For three stations (Hawaii, Ascension, and Congo) only annual means were given, and they have been used for both summer and winter.

Trying to design the lines of flow, it was apparent this could be done only by assuming oblong systems to exist at both sides of the equator, together with a zonal stream winding about the equator. Of these ovals those lying over Central America, Northern Africa, and Southern Asia correspond fairly well with the isobaric Highs found by Sir Napier Shaw at the 8-km. level.

The mean amount of seasonal shifting found above, *i.e.* 10°, fairly agrees with the corresponding shifting of these high-pressure belts at the surface :—

Northern Belt		Southern Belt.	
January ...	32° N.	January ...	37° S.
July	39° N.	July	28° S.
Shift ...	7°	Shift ...	9°

Resuming, it seems probable that in high levels above the equator and winding about it flows a zonal east–west current of stationary character, which is fed by ascending surface-air and locally by air streaming in from higher latitudes, which, moreover, maintains its east–west motion. Also, that from it flows off in other places air to the sub-tropical belts; these currents of deflux bend from an east–west to a west–east direction.

This communication may prove anew that the knowledge of the direction of the cirrus drift in the equatorial belt is important for the investigation of atmospheric circulation between the tropics, but that

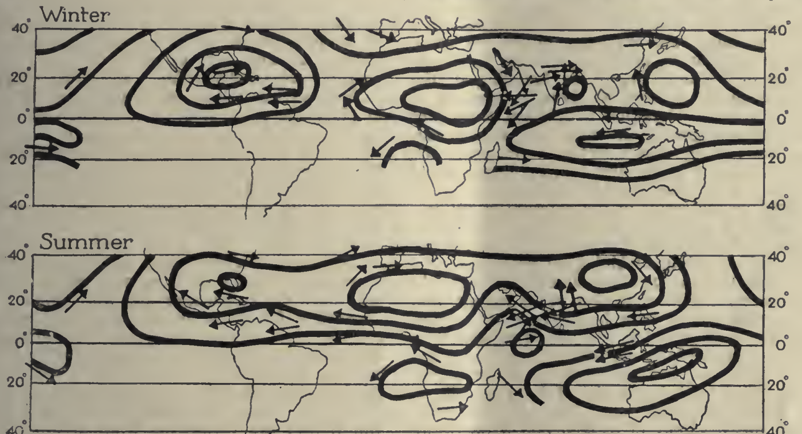

FIG. 1.—Lines of flow of cirrus drift.

Estimating roughly the latitudes of the centres of the current-ovals I find :—

Oval over	Latitude of centre: Winter	Summer	Seasonal shift
Central America ...	20 N.	28 N.	8
Northern Africa ...	8 N.	25 N.	17
Southern Africa ...	?	18 S.	—
Arabian Sea	—	0	—
Bengalese Sea	15 N.	—	—
East Asia	17 N.	30 N.	13
Australia	13 S.	10 S.	3
		Mean ...	10

The mean latitude of the northern ovals is about 20°, that of the southern about 15°. At the surface of the earth pressure is highest in latitudes 35° N. and 30° S.; accordingly, when identifying the current-ovals with pressure Highs, the latter are 15° nearer to the equator at the 11-km. level than at sea-level. This shifting is in agreement with the considerations of Teisserenc de Bort and Exner (*loc. cit.*, p. 177), according to which the high-pressure belts with increasing height move towards the equator.

[6] "Les Bases de la Météorologie dynamique," II. Also Nova Acta R. Soc. Sc. Upsaliensis, ser. 4, vol. 5, No. 1.

the observations at our disposal are few and rather insufficient. For that reason I appeal to those who are in the position to make these observations to supply this need.

To observe in what direction cirrus floats is easy and requires simple means only; moreover, observations are not confined to fixed hours or days. Thus they are particularly adapted to be made by amateurs living in the tropical regions. W. VAN BEMMELEN.

Emmastraat 28, Haarlem, Holland,
December.

Some Problems in Evolution.

THE controversy between Sir Archdall Reid and the biologists is partly concerned with the meaning of terms and partly with the understanding or misunderstanding of physiological processes. Sir Archdall insists on certain interpretations or definitions of the terms "inherited" and "acquired." These terms were first used by the biologists, and Sir Archdall should not give them meanings of his own different from those which they originally bore. He insists that there are two kinds of variation, but only one kind of character. The word "variation" has been used to mean the small differences always found

between individuals of the same species, and also the larger, more conspicuous departures from the average type or normal character. The former are now called "fluctuations," the latter "mutations." Sir Archdall agrees that a variation may result either (*a*) from germinal or (*b*) from nurtural differences, but he repeats his assertion that all characters are alike with respect to acquiredness and inheritability.

Now I presume that when a variation of germinal origin is inherited it is correctly called a "character." For example, the rose-comb in fowls is a character, and we may suppose that it arose as a variation of germinal origin. We know that it is inherited. But Sir Archdall asserts that when it appears in an individual it is also "acquired" because it was not present in the new-laid egg. Here then he is merely, without any justification, giving a new meaning of his own to the term "acquired," which was applied by biologists to those differences which were not of germinal origin. He insists on substituting in this case the term "acquirement" for the term "development."

On the other hand, if a man rows much he develops first blisters, and then corns, on his hands. According to Sir Archdall, this character is inherited because a son would reproduce the character under the same conditions as the parent produced it—that is, under the stimulus of friction due to the handling of the oar. Here again Sir Archdall is giving a meaning of his own to the term "inherited" different from that which biologists originally intended and understood. Supposing the rowing man's father never had such corns, still, according to Sir Archdall, the corns would be inherited. Biologists would say that the corns were acquired as the result of the external stimulus.

What I wish to point out is that this alteration in the meaning and definition of terms is due to a fundamental misunderstanding of biological processes. Sir Archdall states that a fowl reproduces the comb in response to nurture similar to that of its parent, and the man reproduces the corn in response to nurture similar to that under which his parent would have produced it; therefore both are inherited and both are acquired. What is the resemblance between the two cases? The fowl is nourished by the yolk of the egg before hatching and by its food after hatching; it has a supply of oxygen and temperature within certain limits, and "in response" to these conditions the comb develops. The man is nourished by nutriment before birth, by food after birth, requires oxygen and warmth, *and then his hands are subjected to friction* and the corns develop. It is a manifest absurdity to say that the two cases are of the same kind or analogous. It is easy enough to reduce two different phenomena to the same form of words and then assert that they are of the same kind; it may show ingenuity, but it obscures the truth, and is contrary to the methods of science.

The fallacy of Sir Archdall's argument lies in the words "in response to." After admitting the difference between two kinds of variation, he maintains that the comb, or, taking the more special character, the rose-comb, develops in the offspring in response to similar nurture, *i.e.* the same conditions as in the parent, and that precisely the same may be said of corns produced by rowing. But this is not the truth; it is the exact opposite of the truth. The rose-comb is not a "response" to any of the conditions of the nurture. We may take cocks and hens which are the produce of a cross between rose-comb and single comb, and which all have rose-combs; when we breed from them some of the chicks develop single combs and some develop rose-combs. Which comb-character is the "response" to the similar nurture, parents and offspring having all had the same nurture?

Sir Archdall fails to perceive the difference between a condition or stimulus in the nurture which has a direct relation to a structural feature and conditions which have no such relation. In the case of the corns due to rowing, the increased growth is a definite response to the stimulus of friction. In the nurture of fowls there is no stimulus to which the comb or any comb-character is a response. A character is inherited, not necessarily under the same conditions, but under a great variety of conditions, and vast numbers of different characters are inherited under the same conditions. Consider the various plants in a garden: their characters cannot be said to develop in response to nurture. No stimulus or treatment will produce a purple sweet-pea from a white sweet-pea; apart from variations, the different varieties of plants develop the characters of their parents in the same garden under the same conditions. When a stimulus is found which produces a certain change, then that change is an acquired character.

It is an essential point that the fowl develops in response to nurture, but not the comb-character or any other inherited character. Heat at a certain temperature is a necessary stimulus to the development of the egg, but it is not a stimulus to any particular character. The eggs of all the various breeds with all their remarkable colours and other characters can be incubated at the same temperature. It is a fallacy to place the relation of heat to general development in this case in the same category as the relation of friction to corns in the other. The question is: What determines the character? Friction of the hands produces a particular structural change; heat in incubation has no effect whatever on the characters of the breed to which the eggs belong.

Sir Archdall has stated that the corns due to rowing are inherited, and has treated them as a character. In this case, what becomes of the difference between a character and a variation? We may suppose a family of people who have not practised rowing; one adopts the practice and develops corns. Are these a character or a variation? Is the rose-comb a character or a variation? Sir Archdall has tried to show that the two are characters of the same kind with regard to acquirement and inheritability. But if they are variations, what becomes of the two kinds of variation?

Readers of NATURE are probably as weary of this controversy as I am, but Sir Archdall Reid is doing much harm by leading many who have no special knowledge of heredity and evolution to distrust the work of those who are engaged in research on these subjects. Prof. Bayliss recently stated that it was clear from this correspondence that the actual meaning of the terms used was in dispute. I feel that it is necessary, therefore, to criticise Sir Archdall's statements.

J. T. CUNNINGHAM.

East London College, Mile End, E.,
January 28.

IN his recent letter to NATURE (January 26, p. 104) Sir Archdall Reid restates his belief that "all characters are alike as regards innateness, acquiredness, and inheritability." His difficulties in this matter appear to be largely of his own creation, and they might be dissipated if he paid less attention to words and greater attention to the facts of experimental biology.

Sir Archdall Reid admits that there are "two kinds of variation: (*a*) those which result from germinal, and (*b*) those which result from nurtural, differences." That being the case, it surely follows that there are two kinds of characters; for what is a character but

a difference which has arisen at some time through a variation? We can determine characters only by comparing related organisms and noting their differences. To say that all characters are alike, then, is to say that all variations are alike, which Sir Archdall Reid himself admits is not the case.

Perhaps an experimental instance will make this clearer. Some years ago a fasciated specimen of an Œnothera was sent to me. The plant was in seed; the stem was about 2 in. wide at the widest part and as flat as a ribbon. It was, of course, impossible to say with certainty, from inspection, whether this character would be inherited or not, although the probabilities were somewhat against it. I sowed the seeds, large numbers of them, and they all gave rise to perfectly normal plants with round stems. The character was therefore non-inherited in this particular case. It is, of course, well known that fasciations may be produced by excessive nutrition, and that the peculiarity is then, as a rule at least, not inherited.

But there are other instances in which this character *is* inherited. For example, in the common coxcomb of gardens, *Celosia cristata*, fasciation is one of the specific characters, distinguishing it from such species as *Celosia plumosa*, in which the stems do not fasciate under ordinary conditions of cultivation. I have often grown these two species in quantity side by side in the greenhouse, and compared the extreme fasciation of *C. cristata* with the ordinary branched character of the other species. It should be mentioned, however, that *C. plumosa* does sometimes show slight fasciation at the tips of the branches, and this can be exaggerated by growing the plants under conditions of very high temperature and moisture. But it never approaches the degree of fasciation found constantly as a specific (and therefore inherited) character in *C. cristata*.

The same character, fasciation, is therefore clearly inherited in *C. cristata*, but it was not inherited in the particular instance in Œnothera which I tested. It is also clear that the fasciated Celosia must have originated at some time as a variation from plants with normal stems. Innumerable similar instances will be known to experimental biologists, and it is such cases which they have in mind when they speak of characters as of two kinds, inherited and non-inherited. When a particular new character appears as the result of a variation no one can predict with certainty whether it will be inherited or not until the organism which shows it is tested. But, of course, probabilities may be stated by comparison with similar characters the hereditary behaviour of which is already known. In the face of such experimental facts, which are well known to all geneticists, it is futile to state that all characters are equally acquired and equally inherited.

When Sir Archdall Reid implies that combs and corns are equally inherited he forgets a whole class of experimental facts such as those above cited. One must refuse to consider corns as inherited, because there always remains the possibility that a case may arise where, through a germinal change, they *are* inherited without any special stimulus to produce them. The inherited condition known as keratosis is, indeed, an epidermal thickening of similar character. It seems clear that moles are not usually inherited, but if the writer in Nature is correct (see Nature, January 19, p. 78), then there may be instances in which even a mole is inherited in the legitimate sense in which the term "inheritance" is customarily used by biologists.

R. Ruggles Gates.

King's College, University of London,
January 27.

Sir Archdall Reid's letter in Nature of January 26 will render considerable service if it induces students of evolutionary phenomena accurately and precisely to define their terms.

If one may, at the beginning, set forth two general statements, the ground will be cleared for a discussion of Sir Archdall Reid's points:—

(1) Genes or factors are inherited, characters are not.

(2) A gene conditions the appearance in the organism of a character or group of characters.

(3) The effect produced by a gene in the organism depends on the environmental conditions which prevail during the life-history of the organism and on the other genes which the organism possesses.

To show that characters are not inherited, the example of "abnormal abdomen" in Drosophila may be cited.

The gene for "abnormal abdomen" causes the condition in moist cultures only. In dry cultures the flies hatch out normal in appearance.

The statement that rose comb and single comb are not more inheritable than corns on oarsmen's hands is obviously correct. Any capacity for reacting to a stimulus may be considered as being represented in the chromosomes by a gene or genes. In this case we may assume that the capacity for responding to the frictional stimulus of the oar by forming a mass of proliferated tissue on the palms of the hands is inherited.

Certain other points raised by Sir Archdall Reid may be dealt with briefly:

(1) The impure dominant does not inherit any trait. It inherits the recessive gene from one parent which may or may not interact with environment and with other genes to produce an effect. The terms "dominant" and "recessive" are purely arbitrary, and used only for convenience.

(2) The pure extracted recessive inherits a recessive gene from one parent and a similar recessive gene from the other. The germ-cells of an impure dominant carry either the dominant or the recessive gene.

(3) The ancestral condition obtained in some pigeon crosses is due to the interaction of the two sets of genes contributed by the two parents.

The interaction of genes may be illustrated by an example from the cow-pea. A red cow-pea crossed with a white may give a black in the first hybrid generation. White possesses a gene for black which is without effect except in the presence of the gene for red present in the red parent. At least eight different genes in the cow-pea are known to depend for their expression on a single colour-conditioning gene.

S. C. Harland.

[Sir Archdall Reid began this correspondence with a letter in Nature of November 25, 1920; and we have now invited him to close it.—Editor.]

The Radiant Spectrum.

Dr. Hartridge's objections to my explanation of this phenomenon (Nature, September 1, p. 12, and December 8, 1921, p. 467) seem to be based on an imperfect appreciation of Brewster's observations on the subject. Brewster brings out two facts clearly in his paper: First, when a very small and intense source of white light is viewed directly by the eye it appears surrounded by a system of radiating streamers which appear to diverge directly from it; secondly, when a prism of small dispersive power is interposed in front of the eye the streamers are deviated and now appear to diverge from a point lying beyond the violet end of the spectrum into

which the source itself is drawn out. It is clearly illogical to suggest, as Dr. Hartridge does, that the prism is responsible for the radiant phenomenon in view of the fact that, in its essential features, the effect is observed even before the introduction of the prism.

Using a sufficiently intense source of light and a prism of small angle with optically good and clean faces, and making the observations in a dark room, it should be easy for anyone to satisfy himself by simple tests of the kind referred to by Dr. Hartridge that he is in error, and that Brewster's phenomenon really arises from the scattering of light in the eye, the prism merely acting as a dispersive apparatus modifying the colour and disposition of the streamers in the halo surrounding the source. Judging from the statements made in his letter, Dr. Hartridge would appear to have been particularly unfortunate in his choice of experimental conditions. Any noticeable imperfection in the optical surfaces of the prism would, of course, give rise to scattering, masking the true phenomenon due to the eye itself. This is indeed clearly suggested in Brewster's own paper.

A further and absolutely crucial test is also available. In my paper on the scattering of light in the refractive media of the eye (*Phil. Mag.*, November, 1919, p. 568), I have described the character of the diffraction-halo arising from this cause in considerable detail. With a source of white light the halo shows a radiating fibrous structure and clearly marked alternations of colour and intensity in its outer parts. A monochromatic source, on the other hand, exhibits a halo with a granular structure and a succession of bright and dark rings. These features are explained in my paper as due to the diffraction of light by corpuscles of more or less uniform size included within the structure of the eye. On this view we should expect one half of the first diffraction ring outside the central portion of the halo to be partially achromatised on the introduction of the prism and to appear as a detached semi-circular arc lying beyond the violet end of the spectrum and the displaced position of the achromatic centre. No mere imperfections or irregularities in optical surfaces could, on the other hand, give rise to such a phenomenon. Actual trial confirms the expectation from theory and puts its correctness on an unassailable basis.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta, January 4.

The Naming of the Minor Planet No. 907, Barnardiana.

IN NATURE for September 8 last (vol. 108, p. 69), at the end of "Our Astronomical Column," attention is directed to the naming by Dr. Max Wolf of two of his asteroids in *Astronomische Nachrichten*, No. 5116. They are No. 834, Burnhamia, and No. 907, Barnardiana. In commenting on these asteroids NATURE infers that they were named after two American astronomers. While it is true that Prof. Burnham's memory is thus honoured, Barnardiana was not named after me, but in memory of Mrs. Rhoda Calvert Barnard, who died on May 25, 1921. This is evident from the following quotation from a letter to me by Dr. Wolf on the subject:—

"Wenn ich den Vornamen Ihrer Gemahlin gekannt hätte, und—vorausgesetzt, dass er nicht schon verwendet worden ist—würde ich ihn einem meiner Planeten zur Erinnerung an Ihre liebe Frau beigegeben haben. Da das nicht ging, so taufe ich den Planeten 907 1918 EU, auf den Namen: Barnardiana."

For some reason No. 5116 of the *Astronomische Nachrichten* containing these names has only very recently reached the Yerkes Observatory. I was unaware until then that it did not distinctly state the planet was named after Mrs. Barnard. Though not actively engaged in astronomical work, in her long life in astronomy she had endeared herself to the many astronomical people she had met by her thoughtful and unselfish interest in them and in their work. Hers was a life of love and sympathy. I am grateful to Dr. Wolf for thus perpetuating her memory.

E. E. BARNARD.

Yerkes Observatory, University of Chicago,
January 11.

The Resonance Theory of Hearing.

DR. HARTRIDGE imputes to me great absurdities which, either in irony or by an excess of courtesy, he terms "slight errors" (NATURE, January 19, p. 76). Under (1) he takes my plain words, the result "must always be of the same nature," to mean that the result must always be the same! Of course, the harmonic analysis of his oboe and flute combination will not give the same result as in the case of violin and cornet, but in both cases the result will be of the same nature, in that there will be only one fundamental tone. If the data supplied to the sensorium from the cochlea are simply the result of an harmonic analysis, the two notes must appear to the ear inseparably blended in one note. I have not left binaural audition out of consideration. The ability to distinguish two concurrent notes of the same pitch and different quality seems unaffected by both sources being equidistant from either ear.

Under (2) Dr. Hartridge should know as well as I know that the *pitch* of a note depends solely upon the period of its fundamental tone. The example which I proposed eliminates the possibility of beats, the two notes being in perfect physical unison. And, further, since the note made by the teeth is generated by the other note, it cannot be heard except in the combination. Its perception is, therefore, a cognition, not a recognition. *At any instant* during the production of the two notes (which may be sustained for twenty seconds easily) it is possible to turn the attention to the note made by the teeth and to hear that its pitch is that of the hummed note. *At no instant* could the resonators which Dr. Hartridge, outstripping Sir Arthur Keith, "finds" in the cochlea furnish the data for anything but a change in the quality and intensity of the hummed note. This objection remains untouched by Dr. Hartridge's animadversions. It goes to the root of the matter, and cannot "fall to the ground" as a superstructure may.

W. PERRETT.

University College, Gower Street, W.C.1,
January 26.

Aurora Borealis of January 30.

HAPPENING to look out at 11.30 last night I perceived a strong auroral glow extending from N. by E. through N. to W. The light was quite bright, and on going into the garden I noticed that my body cast a shadow and that I could read the headlines of the *Times* quite readily. There were no streamers, but several luminous patches, especially due N., where a blunted cone of greenish light rose vertically up from the horizon to a height of 10°.

The sky was partially, and later almost totally, covered by thin clouds, which drifted up from S. under the influence of light airs. The atmosphere was misty and the temperature decidedly warm.

CHARLES S. LEAF.

7 Grange Road, Cambridge, January 31.

Some Statistics of Evolution and Geographical Distribution in Plants and Animals, and their Significance.

By Dr. J. C. Willis, F.R.S., and G. Udny Yule, C.B.E., F.R.S.

In a paper read at the Linnean Society under the above title on February 2, the statistical methods long employed in "Age and Area" were pushed to their final conclusion. Age and area (review in *Ann. of Bot.*, October, 1921, p. 493) is the name given to a principle gradually discovered in many years of work upon the flora of Ceylon, which, in brief, affirms that if one take groups of not less than ten allied species and compare them with similar groups allied to the first, the relative total areas occupied in a given country, or in the world, will be more or less proportional (whether directly or not we do not yet know) to their relative total ages, within that country or absolutely, as the case may be. The longer a group has existed the more area will it occupy. Tens are compared in order to eliminate chance differences as much as possible, and allied groups to avoid as far as may be the complications introduced by different ecological habit, etc. Herbs, for example, probably spread much more rapidly than trees, but both will obey Age and Area. It is of course obvious that age of itself cannot effect dispersal, but inasmuch as predictions as to distribution of species, occurrence of endemics, etc., can be successfully made upon the basis of age *alone*, it is clear that the average rate of spreading of a given species, and still more of a group of allied species, is very uniform, and therefore affords a measure of age. The result of the work is to show that in general the species (and genera) of smallest areas are the youngest, and are descended from the more widespread species that usually occur beside them.

To Age and Area must be added, as will be shown in a forthcoming book, the twin principle of "Size and Space," which affirms that within any circle of affinity the total of areas occupied by any group of ten genera will go with the total number of species, being large when that is large. The monotypic genera, like the species of small area, must in general be young beginners, and descended from larger genera. Putting these two principles together, it is clear that age, area (or space), and size go together, and as age (representing the resultant of the active factors) is the only working factor of the three, whatever phenomena are shown by size should be similar to those shown by space. But size of genera represents evolution, and area or space represents geographical distribution. These two phenomena should therefore show similar expressions.

But the characteristic feature of geographical distribution, as indicated in all the work upon Age and Area, is that species, whether of endemic or of non-endemic genera, are arranged, as regards their areas of dispersal, in "hollow curves."[1] They show (*cf.* last curve of Fig. 1) many on the smallest area (here one island), fewer on the area next larger (here two islands), and a tail of a few on areas larger again. This type of distribution is practically universal; if one take, for example, a large and widely distributed genus like Cyrtandra, one finds 145 species on small areas, twenty on areas of moderate size, and two on very large areas. If one take the Hawaiian Islands alone, one finds that this genus has twenty-four on single islands, two on two, two on three, and one on four.

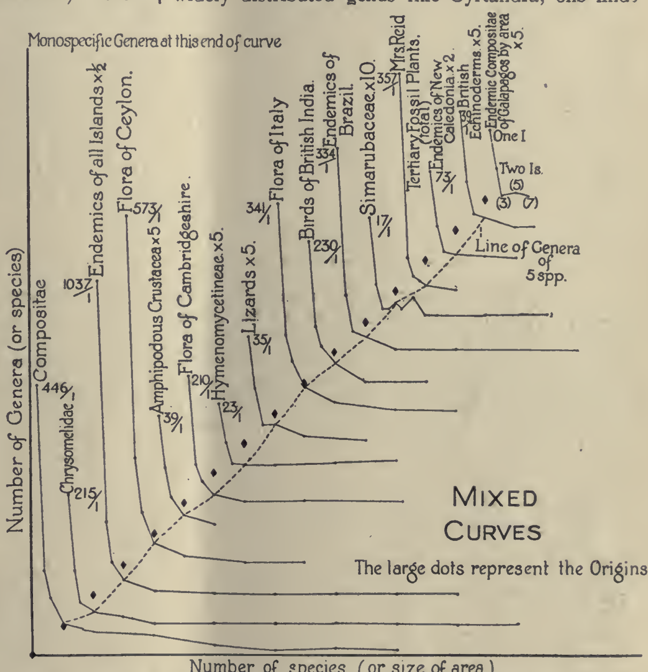

Fig. 1.—Mixed hollow curves. The numbers (thus 446/1) at the beginning of each are the numbers of monotypes.

Now evolution, as expressed in the sizes of genera, shows exactly similar phenomena, and if one group together genera that are associated in any way, systematically, ecologically, or in a given local flora, one gets just the same type of hollow curve, as

[1] By a hollow curve is meant the curve obtained by plotting graphically a series of numbers of which the first is much the largest, while there is a considerable drop to the second and again to the third, and then a gradual falling off to the end. The first two make up about half the total. For instance, a hollow curve will be obtained by plotting 40/1 (40 of one species), 15/2, 8/3, 6/4, 5/5, 3/10, 2/20, 1/30. Many examples are given in Fig. 1.

Fig. 1 shows. It begins with many genera of one species, fewer (but still many) of two, and tapers away in a tail to the larger genera, the tail being longer the larger the family or area dealt with (the tails in the figure are usually very incomplete: Compositæ, for example, run to 1450). A number of

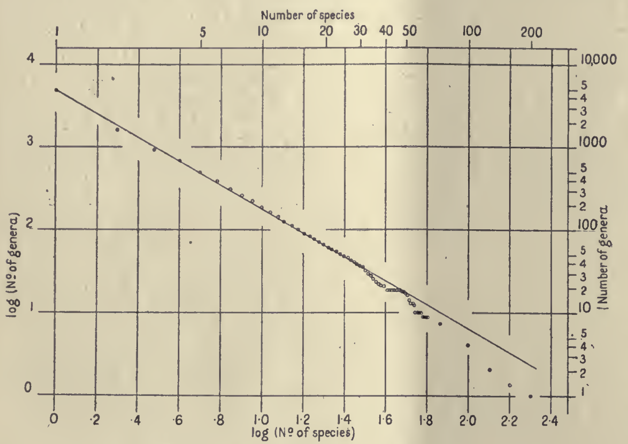

FIG. 2.—Log. curve for all flowering plants.

curves are plotted together in Fig. 1, and show that this type of curve holds not only for all the genera of the world, but also for all the individual families both of plants and animals, for endemic and for non-endemic genera, for local floras and faunas (as may be verified in an hour), and even for very local floras, such as that of Cambridgeshire; it holds even for Wicken Fen and other strictly local associations of plants. It obtains, too, as Mrs. Reid showed in a note read the same evening, for all the deposits of Tertiary fossils examined. For the first three numbers it shows very clearly, but as the numbers become smaller they tend to be irregular, though always diminishing towards the end. If one take only the tens, twenties, etc., one obtains a practically smooth curve.

But now, if species of very limited area and genera of one species (which also have usually small areas) are, with comparatively few exceptions, the young beginners in the race of life, and are descended in general from the species of wider dispersal and the larger genera, and if the number of species in a genus is, broadly speaking, a measure of its age, the idea at once suggests itself that a given stock may be regarded as "throwing" generic variations much as it throws offspring, so that the number of genera descended from one prime ancestor may be expected to increase in geometric ratio or according to the law of compound interest. The number of species descended from one ancestor might be expected to follow the same form of law with a more rapid rate of growth. On such a very rough conception it is found that the form of frequency distribution for sizes of genera should follow the rule that the logarithm of the number of genera plotted to the logarithm of the number of species gives a straight line. Fig. 2 shows the results of this method of plotting for all the flowering plants of the world. The dots give the data, graduated; some process of graduation had to be used, as the statistics were based on the figures given in the "Dictionary of the Flowering Plants and Ferns," which are rounded off in doubtful cases to the nearest 5 or 10 (or greater number in the large genera). It will be seen that, up to genera of some thirty or forty species, there is an excellent fit to a straight line, though there is a marked deficiency of the larger genera—a point on which further investigation is required. Single families show precisely the same rule, the lines not differing very greatly in slope: Fig. 3 gives an illustration of the chart for the Rubiaceæ. Nor is the law one confined to plant life, as is shown by Fig. 4, for the family of Chrysomelidæ amongst the beetles.

It follows from the conception stated that the

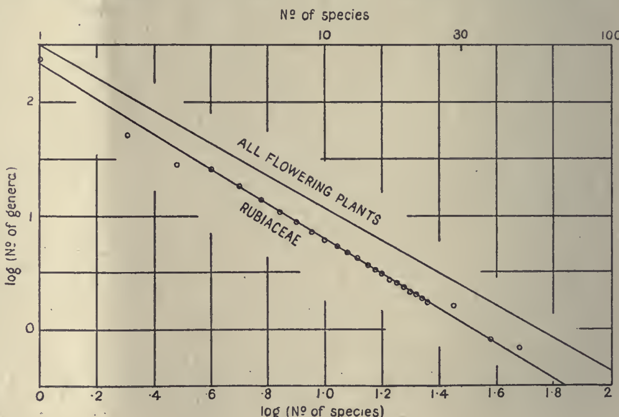

FIG. 3.—Log. curve for Rubiaceæ.

excess of the slope of the line over unity should measure the ratio of the rate of increase of genera to that of species. The slope should always, therefore, lie between the limits 1 and 2, for a slope of less than unity would have no meaning, and a slope exceeding 2 would imply that generic variations

were more frequent than specific variations. Hitherto no exception has been found to the required rule. One group of fungi tested (Hymenomycetineæ) gave a line with a slope very little exceeding unity (1·08), but the figures found for flowering plants lie between the narrow limits 1·38 and 1·64, with an average of about 1·43. Snakes and lizards both give a figure very near 1·50, and the Chrysomelidæ about 1·37.

The development of a more complete theory may in some degree modify conceptions and interpretations, but the results so far obtained suggest that the basic principle put forward is correct.

Inasmuch as all families, both of plants and animals, show the same type of curve, whether graphic or logarithmic, it would appear that in general the manner in which evolution has unfolded itself has been relatively little affected by the various vital and other factors, these only causing deviations this way and that from the dominant plan. And since, assuming that genera "throw" other genera and species, it was predicted that the logarithmic curves would be straight lines, and it was then discovered that they actually were so, it is probable that the assumption was correct. But if this be so, then not only must evolution have been by mutation, but it must also have been, as one of us has contended for many years, by mutations that were at times of rank sufficient to give rise to Linnean species, genera, or even families. Not only so, but evolution must have proceeded on the lines of Guppy's theory of differentiation, the larger genera, and the species of larger area, being the parents of the smaller: *i.e.* it must have proceeded on the whole in the reverse direction to that postulated by the Darwinian theory, as one of us has long maintained.

Finally, it is clear that geographical distribution has been largely mechanical, the general effect of the many factors that are operative being to cause species to spread at a fairly regular speed (differing for each), so that spread forms a measure of age.

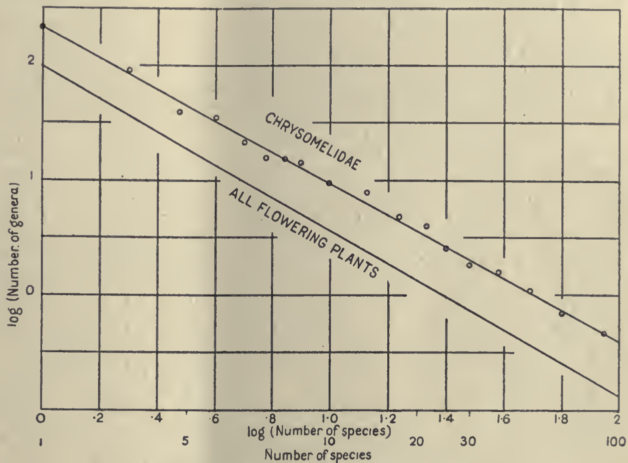

FIG. 4.—Log. curve for chrysomelid beetles.

Space does not permit of detailed argument, which must be left for forthcoming books; but a couple of hours' work at statistics of genera (by sizes) will suffice to make clear the general position taken up.

Some Problems of Long-distance Radio-telegraphy.[1]

By DR. J. A. FLEMING, F.R.S.

II.

ANOTHER cause operating to effect a separation of the positively and negatively charged dust is found in the viscosity of the atmosphere. Roughly speaking, the viscosity of a gas is that quality of it in virtue of which fine particles experience a resistance in moving through it. Maxwell showed long ago that the viscosity of a gas is independent of the pressure over wide limits. Crookes continued these researches and demonstrated that between atmospheric pressure and a pressure of about one ten-thousandth of an atmosphere the viscosity remains constant, but that when the pressure falls below this last figure the viscosity very rapidly decreases to zero. Again, both Maxwell and Crookes found that the viscosity of hydrogen is about half that of oxygen or nitrogen. The viscosity of air at 760 mm. is 0·00018 C.G.S. units.

Sir George Stokes proved that if a small sphere of diameter d and density σ is falling through a gas of density ρ and viscosity μ under the action of gravity it will attain a final velocity v such that

$$v=\frac{1}{18}\frac{d^2g}{\mu}(\sigma-\rho),$$

where g is the acceleration of gravity. This explains the extremely slow rate of fall of water particles constituting clouds, and also the very slow settlement of fine dust particles through air.

The positively-charged solar dust particles are probably larger than the negatively-charged particles, as the latter consist of electrons having condensed round them molecules of gases, probably hydrogen and helium, gathered from the solar chromosphere. Accordingly the negative ions will be brought to rest before the positively-charged particles and gas viscosity will assist the separation.

But Stokes's expressions apply to smooth spheres and not to irregularly shaped particles. Also, if the diameter of the particle is much less than the mean free path of a gas molecule, the expression

[1] Continued from p. 143.

for the frictional resistance, $3\pi d\mu v$, must be divided by $1+2aL/d$ where L is the mean free path of a gas molecule and a is a constant depending on the nature of the particle and its form.

If, then, particles of dust enter the highly rarefied upper hydrogen levels of the atmosphere, they will experience very little retardation until they reach that level (about 100 km.) at which viscosity begins to increase rapidly to its normal or full value, but then they will be very quickly brought to rest even in spite of their high initial velocity.

Hence none of this dust will penetrate below a certain level in the atmosphere, probably from 60 to 80 km. It will be stopped and held by air viscosity. The moment its velocity falls off the forces tending to separate the oppositely electrified particles will also decrease, and the oppositely charged particles may then neutralise each other. The result will be, as I think, to give the highly conductive layer in the earth's atmosphere a tolerably well-defined under-surface determined by the very rapid rate at which air viscosity rises with increasing air-pressure. Hence it is clear that when the dust particles reach a certan level their earthward progress will be practically arrested.

Meanwhile the region above this will be left impregnated with the smaller and lighter negative ions which are moving slowly or quickly in directions oblique to the earth's magnetic meridians and winding their way spiral-fashion towards the regions of the magnetic poles. The explanation of numerous astronomical, meteorological, magnetic, and atmospheric electric phenomena by the aid of this hypothesis of electrified solar dust projected by light pressure from the sun to the earth has been worked out in great detail by S. Arrhenius, K. Birkeland, W. J. Humphreys, and others. This solar dust hypothesis seems to be supported by the observations of Newcomb, Yntema, Abbot, and W. W. Campbell on the fact that on clear moonless nights the sky sends to us more light than can be accounted for by the sum total of starlight, and that this extra light is notably greater near the horizon than at the zenith, and also by the spectroscopic observations which show the green auroral line in all parts of the tropical sky on moonless nights.

In addition to this hypothesis of a permanently conducting upper region of the atmosphere we are compelled to postulate that beneath this there must be a region of variable ionisation due to solar light, which is ionised during the day above the level of clouds, dust, and water-vapour, but more or less dis-ionised during the night.

Dr. Eccles has worked out the consequences of assuming an atmospheric region in which ions of molecular mass are present, possibly formed by the action of ultra-violet light on molecular groups which are photo-electric. The presence of these heavy ions acts so as to produce what is in effect a reduction in the dielectric coefficient and therefore an increase in the velocity of electric waves through the ionised region.

This action may be illustrated by a magnetic parallel. If iron spheres were placed in a magnetic field they would be magnetised, but owing to the reverse action of the free poles the magnetic force in the iron would be less than the force at that point if the iron were not there. Hence the magnetisation produced is not that which corresponds to the external impressed magnetic force, but to the reduced magnetic force.

In the same manner if heavy ions are present in the air the orderly arrangement of them by the impressed field reduces the effective electric force in the space occupied by them, and this is equivalent to a reduction in mean dielectric constant. But the velocity of the wave is inversely as the square root of the dielectric constant, and therefore the wave speed is increased. From this it follows that if there is a gradually increasing density of heavy ions of both signs as we rise higher in the atmosphere, there will throughout that region be a gradually increasing electric wave velocity with height, and therefore an effect which has been called *ionic refraction* in virtue of which the higher levels of a plane electromagnetic wave advancing over the earth will advance more quickly than the lower parts. Hence the wave track will follow round the earth's curvature and an obliquely rising ray may even be brought down again to earth by an action resembling that of an inverted mirage.

The very complicated phenomena connected with freak signalling, the great effect on signal strength of the sunset and sunrise periods, the curious anomalies in the difference between daylight and night-time radio-transmission for various wave-length, and the variation in range between north–south and east–west transmission have all received certain plausible explanations on the theory of a variable ionisation by sunlight of the atmosphere, and its irregularities at the bounding surface of the earth shadow cone as it sweeps through the atmosphere. The atmospheric ionisation at this surface will tend to become "patchy," and will therefore bestow a certain increased opacity and increased reflecting power on that region for electric waves just as small air bubbles in water give it a certain opacity for visible light.

The general increase in range of radio-communication by night is accounted for on this theory as due to partial removal of the ionic refraction which in the daytime brings the ray down again to earth at ranges less than that due to the guiding properties of the permanently ionised higher layer.

There are, however, curious exceptions to this in the case of certain long-wave transmission. Senatore Marconi long ago pointed out that with certain wave-lengths from 5000 to 6000 metres transatlantic radio signals are often stronger by day than by night. These anomalies and others recorded by Dr. Eccles seem, however, to meet with reasonable explanations on the ionic refraction theory.

On the other hand, our difficulties are great in bringing these hypotheses to critical test. The atmospheric region in which the phenomena take place is far beyond the reach of our meteorological sounding balloons or possibilities of testing the actual ionic distribution. We can only, therefore, patiently

continue to collect the facts and trust to cautious inductive reasoning and observations to give us the true interpretation of them. All the phenomena seem, however, to point to the existence of three superimposed layers in the atmosphere: one, the higher, beginning perhaps above 80–100 km., which is permanently ionised with negative ions. The other, the middle, which has in part variable ionisation, depending on the position of that part with regard to the sun. The third or lower level has a relatively small ionisation, but electromagnetic waves travelling in it may have their energy considerably affected and reduced by the nature of the earth's surface over which they are moving. Powerful absorption is caused by some soils and by vegetation for certain wave-lengths.

From the earliest days of long-distance wireless telegraphy the difficulties in reception due to vagrant or natural electric waves and atmospheric electric discharges passing down the receiving aerial have been the bane of the wireless telegraphist. These waves create sounds in the telephone in aural reception which often drown completely the signal sounds and make false records in the case of printing or photographic reception. In the case of telephone reception, these noises have been classified into (1) rattling or grinding, (2) hissing, (3) clicking or snapping, and (4) crashing noises. These last two seem to be associated with thunderstorm conditions. Having regard to the fact that the positive atmospheric electric potential gradient of the earth increases at the rate of abou^ 100 volts per metre of ascent, it is not surprising that aerials several hundred feet high may be traversed by quite large currents, due to this cause alone, which may utterly swamp the feeble signal currents. The strength of a signal or noise in the telephone is generally estimated by its "audibility," and this is measured by ascertaining the resistance S of the shunt which must be put across the telephone of resistance R just to render the sound inaudible to a normal ear. The audibility A is given by the expression $A=(R+S)/S$. Hence the audibility is unity for a just audible sound. We can in this way measure the audibility of a signal on a background of disturbing noise, and a readable signal is generally obtained if the ratio of signal audibility to stray audibility is more than 25 per cent.

Owing to the serious extent to which these strays hinder regular reception, especially at certain times of the day and year, an enormous amount of attention has been given to their study and to the problem of eliminating them. They are most troublesome in the summer and during the night, and more severe in tropical than in temperate climes. Even in our latitudes they hinder reception at times immensely. Dr. L. W. Austin has stated that receiving at Washington, U.S.A., with a simple loop aerial from high-power radio stations in Europe with aerial sending currents up to 300 amperes, signals were unreadable for about 2000 hours a year. In tropical countries over long-distance circuits the power required to get a signal through may be often from six to eight times that which must be used at favourable times, and there are short periods when signalling is absolutely impossible. Having regard to the effect such interruptions have upon the earning power of a commercial station or upon certainty of communication in time of war or other urgent occasions, the problem of elimination of strays is perhaps the most important of all the practical questions connected with long-distance wireless telegraphy. It has been the subject of countless patents already. Early attempts went on the supposition that the strays were highly damped vagrant waves or had particular frequencies and could be eliminated by giving the receiving system a very pronounced resonance and making it a so-called stiffly-tuned circuit. These methods had a very limited application, for the reason that any impulse given to the receiving aerial sets it in electric vibration with its own natural period. Then, again, a number of inventions depend upon the peculiar properties of certain detectors, such as crystals and thermionic valves, in limiting the current which they pass or rectify. One most practically useful discovery was that by giving to the spark or wave train in the case of spark systems, or to the beats in the case of C.W. heterodyne reception, a regular frequency of 500 or 600, thus imparting a rather shrill musical sound to the signal, the ear could much more readily fasten attention on it even against a background of irregular but louder noise due to atmospherics.

Dr. de Groot made an immense number of observations on stray strengths at various hours of the day and months of the year about 1916 in the Dutch East Indies, and prepared diagrams showing the mean stray strength for various hours for each month of the year. From these he prepared a diagram giving the hourly stray strength during the day averaged throughout a year. The results were that in general the strays were more numerous and stronger during the night than during the day.

We have seen that there must be a certain intermediate but high-level region in the atmosphere in which the gases are ionised by the ultra-violet sunlight during the day, but re-combine again during the night. This region lies beneath the permanently ionised layer. In this permanently ionised layer there are drifting collections or masses of positively electrified and negatively electrified solar dust. If these masses are drawn together by their electric attractions or commingled, it is highly probable that electric recombinations will occur, which would generate electric waves. Suppose, then, that we assume the origin of a certain part of the strays to be in the upper permanently conductive layer of the atmosphere, these natural waves would find a certain obstacle to their downward transmission in the conductivity produced by the ionisation of the middle layer of the atmosphere by day. But at night-time this middle layer ionisation largely disappears and the natural electric disturbances in the upper layer would more easily find their way down to the earth. In other words, there would be a more unhindered access for the strays to descend. Hence in the night-time they would be more numerous

and more apparent in the effect they produce on receiving appliances.

The view that the strays which produce continuous rattling or grinding noises in the telephone have their origin in the high-level permanently conductive layer of the atmosphere was also put forward by Dr. de Groot, and he has employed ingenious arguments to obtain an estimate of the height of this layer, which he places at between 180 and 200 km.

These estimates must, however, be brought into comparison with the observations which have been made on the heights of the aurora. Störmer has made precise measurements of the parallax of the beams and arches of auroræ by photographic observations at places connected by telephone, and found, out of 150 observations, that the lowest occurred at 40 km. and the highest at 260 km. Much, however, depends upon latitude and the height of the region ionised by cosmic dust may be greater at the terrestrial equator than at the poles. The whole subject is of great importance in connection with meteorology and terrestrial magnetism, and invites the co-operation of physicists, astronomers and meteorologists, as well as radio-engineers.

The matter is, however, of such immense practical importance in radio-telegraphy that improvements or inventions connected with it are generally kept as carefully-guarded secrets, at least, for some time. Senatore Marconi spoke recently of inventions due to himself and his technical staff which promise a great advance in overcoming the interruptions of service due to strays, but details are at present withheld.

The problem of eliminating altogether the effect of strays on the receiver is at present the paramount one in long-distance wireless telegraphy, as they are a source of far greater difficulty than in short-distance working.

A Journal for Physical Measurements and Instruments.

READERS of NATURE, whether physicists or others, will be interested to learn of the steps which are being taken and the progress which has been made in connection with the proposed new journal dealing with physical instruments, the first important task which the newly founded Institute of Physics has set itself to accomplish. At the National Physical Laboratory the need for such a journal has long been felt; accordingly in 1919 the director addressed a letter directing attention to the needs of a number of Government departments and workers in various branches of science.

The response was most gratifying. The Admiralty, War Office, Ordnance Committee, engineering department of the Post Office, and other important bodies, all wrote approving the suggestion and in many cases offering support, while men of science—physicists, physiologists, miscroscopists, zoologists, and engineers—warmly commended the scheme, which also received the support of some leading instrument makers, including the British Optical Instrument Makers' Association and the British Electrical and Allied Manufacturers' Association. As a result the Institute of Physics brought the proposal before the Department of Scientific and Industrial Research. A meeting was held between representatives of the department and of the institute under the chairmanship of Sir J. J. Thomson, at which a suggestion was made that a single number might be prepared and issued as a specimen with the view of seeing what support could be obtained.

This suggestion was, at a later date, conveyed in a more formal manner to the department and approved by their advisory council, and a joint committee appointed by the department, the National Physical Laboratory, and the institute has been formed to give effect to it.

The institute has accepted financial responsibility for the publication of the journal provided scientific and industrial associations and individuals to whom the journal will be of service are prepared to furnish adequate guarantees for its support. The department will make a grant towards the cost of printing the specimen number.

The institute is to have the assistance of the staff of the National Physical Laboratory in the preparation of this number, and Dr. Rayner has, at the request of the committee, undertaken the duties of editor. An announcement of the proposed journal has been prepared and will be widely circulated along with a request for support, and it is hoped that the response will be such as to enable the institute to continue the task it has set itself and produce a work which will fill the acknowledged need.

Obituary.

SIR HENRY JONES.

IN Sir Henry Jones, professor of moral philosophy in the University of Glasgow, who died on February 4 at his home in Argyllshire, we lose one of our greatest teachers and, since Edward Caird, the leading representative of the Hegelian influence and tradition in English university life. A pathos surrounds the last few years of his life and also throws light on his personal character and strong mentality. He struggled against the painful disease which has proved fatal with a courage nothing short of heroic. He refused to give up, or even to slacken, his regular work. He persevered with his last undertaking, the Gifford lectureship, under conditions which few could have endured. He lectured even when speech was becoming

physically difficult, and he succeeded in delivering the first course. The second course has been interrupted by death, but the series of lectures is written and about to be published under the title "A Faith that Enquires."

Sir Henry Jones was born in 1852 in North Wales. In his twenty-third year he obtained the means to enter as a student in the University of Glasgow, and there came under the influence of Edward Caird, from whom he learnt the Hegelian idealism of which he was throughout his life an enthusiastic and consistent exponent. In 1878 he graduated with first class honours in philosophy and became Prof. Caird's assistant. After various appointments, and when Prof. Caird became Master of Balliol in 1894, he was appointed his successor and has held the chair since. He was an LL.D. of the University of St. Andrews, a D.Litt. of the University of Wales, and a fellow of the British Academy. He was knighted in 1912. He served on the Commission of Inquiry which preceded the Act for the Disestablishment of the Church in Wales. His name was included in the last New Year's honours list.

It is as a teacher that Sir Henry Jones will live in the memory of the many students who were inspired by him. As an author the value of his work is literary and social rather than scientific or philosophical. His books are popular expositions, marked, indeed, by keen appreciation and insight, but motived by strong moral enthusiasm rather than by any theoretical interest in investigating scientific or philosophic problems. His most important work in philosophy was a small volume on "The Philosophy of Lotze," published in 1894, which was for many years the chief source for English readers of their knowledge of the philosophy of the German professor.

PROF. V. GIUFFRIDA-RUGGERI.

DR. VINCENZO GIUFFRIDA-RUGGERI, professor of anthropology in the University of Naples, one of the leading anthropologists in Europe, died on December 21, after a brief illness. He was born at Catania, Sicily, in 1872, became a doctor of medicine in the University of Rome, 1896, and was thereafter appointed assistant to the professor of anthropology in that university, G. Sergi. He then commenced a career of extraordinary industry, contributing year after year some eight or ten original papers to the current literature of his chosen subject. Although Prof. Giuffrida-Ruggeri neither initiated any form of revolutionary idea nor opened any new chapter, yet his voluminous writings reflect more fully than those of any other writer the anthropological problems discussed by his contemporaries in Europe and America. The papers of his earlier years were devoted to studies of the skull, particularly of the face, but as time went on they broadened out into a study of human races in all parts of the world. He made a close study of the fossil remains of man, and in more recent years devoted himself to the evolution of man and to the origin and relationship of modern human races. The conclusions he had reached are set forth in two of his more recent books, "L'Uomo Attuale, Una Specie Collettiva" (1913), and "Su l'Origine dell' Uomo," 1921. By his death modern anthropology loses one of its most imposing and interesting figures.

A. K.

Current Topics and Events.

MME. CURIE was elected a free associate member of the French Academy on Tuesday—an event which marks a red-letter day in the history of feminism, and is a richly merited recognition of the memorable achievements of a woman who, although not French by birth, has conferred imperishable lustre on French science. So signal a distinction—unique in the history of that particular section of the Academy of which Mme. Curie becomes a member—is but the just reward for services rendered, not only to France, but also to the whole world, and brings honour to the illustrious body that has bestowed it. It was significant of the universal sentiment of approval with which Mme. Curie's candidature was greeted that her several male competitors should, one after the other, have waived their claims in her favour—a circumstance which adds a measure of grace to her triumph. On behalf of British workers in science—men and women—we beg to tender our warm congratulations to the new Academician, and trust she may long enjoy her well-earned *fauteuil* among the Immortals.

THE address of the president of the Paris Academy of Sciences, M. Georges Lemoine, published in *Comptes rendus* of December 12 last, refers to matters which must be kept in mind in England also. After pointing out the growing necessity for costly apparatus and laboratories in the progress of physical and natural science, M. Lemoine deplored the fact that the most important factor of all, namely, the man of science himself, is being more and more tempted to forsake the domain of science and to devote himself to industrial pursuits. Although the general rise of prices may partly account for this fact, it does not justify it. The supply of research workers from the universities and colleges is insufficient for national needs. It is absolutely necessary for the production of good work that the material conditions of existence should be assured for a much larger number of young men of science, at all events for a period of a few years. But there must also be an adequate number of posts, teaching and otherwise, free from anxiety as to the supply of daily needs and affording time for individual work, to which the young investigator can look forward as a future career. The address closes with an eloquent appeal to young people not to place too high a value on material wealth, but to remember the incomparable satisfaction which awaits the discoverer of new knowledge.

THE recent offer of a prize of 22,000*l.* by Lord Atholstan to the discoverer of a medicinal cure for cancer has been followed by one of 10,000*l.* by Sir William Veno for the same purpose. These offers have naturally created a good deal of interest, not only among the general public, but also among those engaged in the organisation and prosecution of cancer research. If successful treatment of this disease is going to be secured, it is certain that more financial support must be given to investigators than has been provided in the past. The present difficulties of this provision are so acute that Lord Athlone, the chairman of the Board of the Middlesex Hospital, has directed the attention of these intending benefactors to the urgent need of supporting existing researches. We are glad that this suggestion has been acted upon, for it is now announced that Lord Atholstan has given an additional 22,000*l.*, to be used for research work in cancer, and Sir William Veno has agreed that his gift should be used for research. It is possible that some further financial help may come for cancer investigation in this country as well as in others. Should this eventuate, it might well be the opportunity for some concerted action among the different cancer research centres. At present investigations upon causation or cure are unco-ordinated, and something might be gained by intensive work along avenues which a collective opinion would indicate.

AN earthquake of great interest, though by no means of the first order of magnitude, occurred on January 31 at 1h. 17m. 30s. p.m. (Greenwich mean time). In the United States the oscillations were so large that seismographs at Washington and Harvard University were temporarily put out of action. The origin was about 600 miles from San Francisco, 2420 from Ottawa, and 5140 from Oxford. In a letter to the *Times* of February 3 Prof. H. H. Turner locates it in lat. 42° N., long. 125° W., or about sixty miles from the coast where Oregon joins California. The shock is said to have been felt at many places along the Pacific coast as far as the Canadian border, and this seems to point to an elongated focus parallel, or nearly parallel, to the coast-line. It is interesting to notice that the epicentre lies along, or close to, the continuation, some two or three hundred miles to the north, of the San Andreas fault. Except for three short interruptions by the sea, this great fracture has been traced from Cape Mendocino on the north to the Colorado Desert on the south, a distance of more than 600 miles, and it was along its northern half, from Cape Mendocino to San Juan (about 290 miles), that the remarkable displacement occurred which gave rise to the San Francisco earthquake of 1906.

SOME disappointment has been expressed in Glasgow regarding the refusal of the managers of the Royal Infirmary to undertake the permanent retention on its present site of the old ward which was formerly occupied by Lord Lister, and in which his first successful experiments in antiseptic surgery were carried out. The infirmary has been largely rebuilt, and the old ward is said to obstruct the lighting and ventilation of the newer structure. The Lister Memorial Committee proposed to preserve the ward in perpetuity and fit it up as a museum of relics, portraits, etc. Failing in this purpose, the committee has now decided to devote its funds to the erection of a statue of Lister, near that of Lord Kelvin in the Kelvingrove Park, on the slope adjoining the University, in which they were colleagues as professors. The Lister relics collected by the committee will be displayed in the hall of the Pathological Institute at the Royal Infirmary. Meanwhile, no immediate steps are likely to be taken for the demolition of the old ward.

AT the meeting of the Royal Geographical Society on Monday, February 6, the president announced that this year's Mount Everest Expedition is already in movement. The definite sanction of the Tibetan Government has just been received, and Gen. Bruce has left England for India to make all the initial preparations, especially the organisation of a corps of Himalayan porters at Darjeeling. Lord Rawlinson has particularly attached himself to the expedition, and through his interest it has been possible to secure the services of Capt. Geoffrey Bruce, of the 6th Gurkhas, to help his cousin in the very important work of training, equipping, clothing, and feeding these porters. A second Gurkha officer has also been asked for. Besides these there will be six climbers, Lt.-Col. E. L. Strutt, Mr. Mallory (from last year's expedition), Mr. George Finch, Mr. Somervell, Dr. Wakefield, and Major Norton—all in the first rank of mountaineers. The veteran Himalayan climber, Dr. T. G. Longstaff, will accompany the expedition as physicist and naturalist, and Major J. B. Noel will act as photographer. Before the end of March these will all have arrived in Darjeeling, and a start will be made in time to reach the base camp near Mount Everest early in May.

THE National Institute of Industrial Psychology was founded in 1919 by the co-operation of Dr. C. S. Myers and other psychologists, with representatives of several well-known industrial firms, and it was finally incorporated in February, 1921. We now welcome the appearance of the first issue of the Journal of the institute, which is to appear quarterly. This journal aims at describing in non-technical language the methods and results of applying scientific knowledge to the human aspects of industry. It will publish accounts of research and propaganda work carried out, not only by the institute, but also by other similar bodies and by individual investigators, and will contain abstracts and reviews of books, reports, and periodicals. Amongst other contributions the present issue contains accounts of investigations on tin-box manufacture and on chocolate packing, in which it has been possible by the introduction of simple improvements in the methods of work to improve output by 30 to 40 per cent., and at the same time to diminish the fatigue of the workers. The assistant director of the institute, Dr. G. H. Miles, discusses vocational guidance, and Mr. Eric Farmer describes the reduction of

fatigue through the adoption of rhythmical methods of work in various industries.

A SUGGESTION has reached us from Mr. F. J. W. Crowe, St. Peter's House, Chichester, that fine concrete might be used for making mirrors of large size and accurate surface such as are employed in large reflecting telescopes for astronomical work. Dr. J. W. French, of the firm of Messrs. Barr and Stroud, to whom we submitted the communication, is of the opinion that such a surface would not be satisfactory. Silvering shows up minute defects very plainly; in fact, rustless steel is the only material other than glass which gives reasonably good results, and to grind a plaster surface with the necessary accuracy would be almost impossible on account of the way in which all plasters absorb water. The greatest difficulty to be met, however, is the distortion which occurs when plaster sets. Both at the time of setting and afterwards there are rapid crystalline changes which may continue for at least one year. Any plaster containing unslaked lime will undergo distorting changes which would make the production of a good optical image impossible. This defect might be remedied by using a blend of cements, but, unfortunately, they are not of a kind that could be worked to give a good continuous surface.

IN a report to the Mercantile Marine Department of the Board of Trade on the proposed standard of rejection of seamen for colour-blindness, Dr. Edridge-Green states that 5 per cent. of men have diminished colour perception. As there is a gradual change from normal to absolute colour-blindness, it is difficult to fix a point at which it shall be considered that colour-blindness incapacitates a man from work as a seaman. The Nautical Advisers of the Board of Trade agree that a man who can distinguish between red, green, and white lights a mile distant shall be considered competent. Dr. Edridge-Green finds that the men who fail under this test can see only three or less distinct colours in the spectrum, while those who pass the test see four or more. He therefore fixes the line of demarcation between those who can distinguish red, yellow, green, and violet and those who see only red, green, and violet in the spectrum.

THE National Institute of Botany has recently issued a very encouraging Second Report (1920–21). During the year the headquarters at Cambridge were completed and came into use, the official Seed Testing Station being transferred thereto in September last. Within a month a private visit was paid by their Majesties the King and Queen and Princess Mary, who expressed their appreciation of the importance of the work carried on. In order to bring the institute into closer touch with the agricultural community a fellowship is being established (annual subscription one guinea), in which Mr. Lloyd George has asked to be enrolled as one of the first life fellows. For the welfare and progress of the work it is essential that a considerable income be raised by annual donations and subscriptions, and it is hoped that very many agriculturists will avail themselves of the opportunity of assisting in this by becoming fellows. In the crop improvement branch, field trials of cereals have been established, "preliminary trials" being made to provide seeds for "full trials" which will last for two years. A collection is also being made of stocks of varieties of cereals, especially of historical varieties of wheat, some of which are rapidly disappearing. An interesting feature of the current year's work will be an exhibition of yield trials of growing cereals and potatoes on the Royal Agricultural Show ground in Cambridge. At Ormskirk the immunity and maturity trials of potatoes have been continued; they indicate that the system of experiment used promises to lead to satisfactory results when modified and extended over a longer period of time. The official Seed Testing Station reports a considerable increase in the year's work, in spite of the disorganisation due to the transfer from London. It is proposed to hold a summer course for the training of seed analysts, and a handbook of seed-testing methods is in preparation. An International Conference on Seed Testing at Copenhagen was attended by representatives of the institute, and it is hoped that the next conference in 1924 will be held partly at Cambridge.

IN the French newspaper *Savoir* for December 24 last Prof. Capitan discusses Mr. Reid Moir's discoveries of worked flints at the base of the Crag near Ipswich and in the Forest Bed near Cromer. He concludes that the simple chipping round the edges of these flints is undoubtedly the work of man or one of his precursors. He therefore agrees that Mr. Reid Moir has found definite evidence of Pliocene man in Britain.

SIR OLIVER J. LODGE will deliver the fifth Silvanus Thompson memorial lecture at a special meeting of the Röntgen Society to be held on Tuesday, March 21, at the Institution of Electrical Engineers.

ON Thursday next, February 16, Prof. Arthur Perkin will begin a course of two lectures at the Royal Institution on "Dyeing: Ancient and Modern"; and on Saturday, February 18, Prof. Ernest Gardner will deliver the first of two lectures on "Masterpieces of Greek Sculpture." The Friday evening discourse on February 17 will be delivered by Prof. D. S. M. Watson on "The History of the Mammalian Ear."

THE annual general meeting of the Institute of Metals on March 8–9 will be held at the Institution of Mechanical Engineers. On the opening day of the meeting the new president, Mr. L. Sumner, will deliver his inaugural address, and in the evening the annual dinner of the institute will be held at the Trocadero Restaurant, Piccadilly Circus, W.1. Papers on the constitution and properties of copper and aluminium and their alloys will occupy the scientific sessions of the meeting.

IN the annual report of the Physical Society to be presented at the annual meeting to-morrow, February 10, it is stated that Prof. A. Fowler has prepared for the society a report on "Series in Line Spectra," which will shortly be issued. A second

report on "Atomic Structure," by Prof. Bohr, is in preparation. An appeal for funds for a Duddell memorial medal resulted in a sum of about 650*l.* being raised. The committee dealing with the memorial has asked Mrs. Mary G. Gillick to undertake the preparation of the medal, which it is hoped will be ready during the early part of 1922.

THE following lecture arrangements have been made by the Royal College of Physicians of London :—The Milroy lectures on "The Influence of Industrial Employment on General Health," by Dr. Major Greenwood, on March 9, 14, and 16; the Goulstonian lectures on "The Interpretation of Symptoms in Disease of the Central Nervous System," by Dr. A. Feiling, on March 21, 23, and 28; the Lumleian lectures on "Diseases of the Thyroid Gland," by Dr. H. Mackenzie, on March 30 and April 4 and 6. The lecture-hour in each case will be 5 o'clock.

IN a paragraph in NATURE of February 2, p. 151, it was suggested that the list of British research chemicals issued by the Association of British Chemical Manufacturers should be revised and issued as soon as possible. Mr. W. J. U. Woolcock, general manager of the association, informs us that the suggestion has been anticipated, and that a revised and enlarged edition of this list is at the moment in the press. Not only will this second edition contain a larger number of organic chemicals, but inorganic chemicals will also be included.

MANY libraries doubtless contain duplicates of astronomical periodicals and books that are needed in other institutions. For the purpose of facilitating their purchase, exchange, or gift, the National Research Council contemplates the compilation of a list of all duplicates that can be spared. This list will be mimeographed and widely distributed. Those who have duplicates to dispose of are asked to send a list of them to the National Research Council, Division of Physical Sciences, 1701 Massachusetts Avenue, Washington, D.C., U.S.A. A copy of the complete list will be sent on application.

Our Astronomical Column.

CONJUNCTION OF MARS WITH A STAR.—Mr. W. F. Denning writes :—The planet Mars will make a very near approach to the star β Scorpii (third magnitude) on the night of February 22. Mars will rise at 1.35 a.m. on the morning of February 23, and the planet may be observed if the sky is clear from that time until sunrise, with the star lying slightly to the north-west. It will be interesting to watch the gradual approach of the two objects from the present time up to the date of conjunction, and then to follow them as the distance between them becomes greater from night to night. On February 10 Mars will be 7° west of the star, and on March 7 7° east, its motion carrying the planet daily about half a degree eastward. The near approach of the two objects may be followed with the unaided eye, though the view will be much improved by means of a field-glass or telescope.

COMET NOTES.—H. Mahnkopf gives the following search ephemeris for comet 1916 I (Taylor), due at perihelion about 1922 June 13. It is for Greenwich midnight. Magnitude about 15:

		R.A. h. m.	S. Decl. ° ′			R.A. h. m.	S. Decl. ° ′
Feb.	10	1 26·1	4 21	Feb.	26	1 54·5	0 5
	14	1 32·8	3 18				N. Decl.
	18	1 39·8	2 14	Mar.	2	2 2·2	1 0
	22	1 47·0	1 10		6	2 10·2	2 6

Log r, log Δ, February 2, 0·303, 0·357; February 18, 0·284, 0·368; March 6, 0·264, 0·376.

A new very faint comet, 1922*a*, was discovered by Mr. W. Reid at the Cape on January 20; its place on January 24d. 9h. 34·3m. G.M.T. was R.A. 9h. 54m. 30·9s., S. decl. 33° 46′ 31″; daily motion *minus* 56s., south 7′.

INTERNAL MOTIONS IN THE SPIRAL NEBULA M 81.—The *Astrophysical Journal* for December contains Mr. van Maanen's discussion of the internal motions in this spiral deduced from two photographs taken with the 60-in. reflector at Mount Wilson at an interval of eleven years. The results of an earlier discussion based on a six-year interval are in all cases confirmed in sign, but the numerical values are considerably increased. Taking 0·001″ as unit, the mean of 104 points measured gives the rotational component as 38, the radial component outward as 13, the stream motion (along the whorls of the spiral) as 39, and that transverse to the whorls as 7. The indicated periods of rotation about the centre for four spirals are :—For M 101, 85,000 years; for M 33, 160,000 years; for M 51 (Canes Venatici), 45,000 years; and for M 81 (Ursa Major), 58,000 years. These figures are all much smaller than any possible period of rotation of the Galaxy, and seem to indicate an entirely different character for these objects. The only possible way of avoiding this issue would seem to be the adoption of Dr. Jeans's suggestion that the Galaxy was originally much more compressed than it is now, so that its period of rotation would have been shorter.

It is, however, emphasised, that the motion is not pure rotation, but outward along the spiral arms. The figures given have been corrected for foreshortening, the plane of the nebula being inclined 49° to the celestial sphere. The proper motion of the nebula referred to fourteen faint comparison stars is +0·014″ per annum in R.A. (great circle) and −0·005″ in dec.

Sixty-three stars in this region, of about the ninth magnitude, have a mean motion of −0·0014″ in R.A. and −0·0047″ in dec. (Greenwich Astrog. Cat., vol. 4). It is therefore probable that the greater part of the motion of the nebula in R.A. belongs to it, and not to the stars.

The author considers that the character of internal motion established in several spiral nebulæ supports Dr. Jeans's theory that the spiral form is due to tidal action arising from the approach of two nebulous masses.

Research Items.

Culture of Ancient Peru.—One difficulty in the sequence-dating of the textiles of ancient Peru, which, with the pottery, are the best evidence of the pre-Spanish culture, is that Peruvian looms are very scarce in museums, and, when found, are usually incomplete, and almost invariably undatable, even in accordance with the sequence-dating at present accepted. In *Man* for December last, Mr. T. A. Joice reports that a vase presented to the British Museum in 1913 by Sir Herbert Gibson shows a definite and indisputable correlation between a certain type of loom and a certain type of pottery. This vase, which definitely belongs to the Proto-Chimu period, that is to say, the earliest period of any sort of developed culture on the northern Peruvian coast, presents a scene showing the weaving of tapestry on a loom without a treadle, and associated with pottery also belonging to the same early period. It does not prove, but it suggests, that the principle of the treadle was unknown to the Proto-Chimu weaver; if so, then the treadle belongs to a comparatively late period of South American culture. Much further inquiry is needed before the significance of this discovery can be used as a proof of sequence-dating.

Parasitic Worms from Animals.—Dr. G. A. MacCallum gives (*Zoopathologica*, vol. 1, No. 6, 1921, published by the New York Zoological Society) an account of parasitic worms from animals in the New York Zoological Park and Aquarium, with a figure and brief description of each species; some of the descriptions, however, are too brief and not altogether serviceable. A new species of Heronimus is viviparous—the uterus contains miracidia. The author, who is pathologist to the New York Zoological Society, deserves commendation for his zeal in searching for and recording the parasites of the animals which pass through his hands.

Indian Marine Polychæta.—A further instalment of the reports on the fauna of the Chilka Lake has been published in vol. 5, No. 8, of the Memoirs of the Indian Museum. This part contains a systematic account of the Polychæta by Mr. R. Southern, who also reports on collections from the Gangetic delta and from the Cochin backwater. The majority of the species live either in brackish water of low salinity or are euryhaline, *i.e.* can live in water the salinity of which varies between wide limits. Euryhaline forms appear to be relatively more numerous in India than in Europe, and Mr. Southern suggests this adaptation may be correlated with the sharp division of the climate into wet and dry seasons, one result of which is that the littoral region, especially in bays and estuaries, is periodically flooded with water of low salinity. Mr. Southern points out that there are so few records of Indian littoral marine Polychæta that there is no basis for instituting a comparison between the Polychæta of the lake and those of the seashore. Of the twenty species from the lake, eighteen are described as new. The collection has a typically marine facies, and probably represents an impoverished remnant of the Polychæta which inhabited the open bay before the present lake was almost completely cut off from the Bay of Bengal by the spit of sand which forms its eastern boundary.

Selection Experiments with Cladocera.—Dr. A. M. Banta has published (Carnegie Institution of Washington, Publication No. 305) the results of extensive selection experiments with Cladocera. He chose responsiveness to light, as measured by reaction-time, and selected simultaneously in different strains for increase and decrease of this physiological character. Pure lines of Simocephalus and Daphnia have been bred parthenogenetically for more than eight years. In such parthenogenetic eggs there is only one maturation division, and in the absence of a reduction division there is apparently no opportunity for segregation or recombination of genetic materials. In the course of the experiments a great deal has been learned about the biology of the organisms, and their reactions to varying environments. Selection experiments produced a significant difference between plus and minus strains in only one of fifteen distinct lines studied, although there were indications of an effect in several others. The nature of this effect of selection is discussed at length. The change appears to have been a gradual one, which can scarcely be accounted for by the occurrence of a few marked mutations. The two strains obtained differed only in reactiveness to light, and this difference was maintained for at least 112 generations after selection ceased. These results would appear to limit the universal application of Johannsen's law that selection within the pure line is of no avail in modifying its genetic properties.

Factors of Growth and Multiplication.—Two recent papers (*Biochemical Journal*, vol. 15, pp. 595–612) by Prof. Brailsford Robertson contain some important observations on the mutual influence of individual organisms in promoting growth and multiplication. Working with the ciliated protozoon Enchelys, he shows that it feeds mainly upon bacteria, and that its rate of growth is much influenced by some soluble thermostable substance which arises from them. During the early stages of development of a culture the multiplication rate increases progressively with each division, and partakes of the autocatalytic character which has been previously described in various animals and plants from man downwards. This has nothing immediately to do with its food, but depends on the contiguity of the infusoria, and in a special series of experiments Prof. Robertson shows that a culture started with two individuals will produce, not twice, but about five times as many descendants in twenty-four hours as a culture started with a single Enchelys. Conjugation was never seen under the conditions of the experiments, and the effect appears to be due to some accelerator substance produced by the protozoa in the presence of the accelerator arising from the bacteria. It would be of much interest to determine whether the same phenomena accompany the growth of an organism feeding only on soluble substances such as the bacteria-free race of the ciliate Colpidium described by Dr. Peters (*Journal of Physiology*, vol. 55, p. 1), where the conditions are much simpler than those examined by Prof. Robertson.

Mixed Products of Granitic Intrusion.—Mr. Charles H. Clapp, in his study of "The Geology of the Igneous Rocks of Essex County, Massachusetts" (U.S. Geol. Survey, Bull. 704, 1921) makes a noteworthy claim for regarding several unusual types of rock as products of the intermingling of an invading granite with material derived from the cover into which it penetrates. He recognises a gravi-

tational differentiation during crystallisation as accounting for the production of an underlying gabbro-diorite and an overlying granodiorite from an original basaltic magma; but granite afterwards intruded into the more basic of these masses, and has produced a number of "hybrid" rocks. The gabbro-diorite was cold at the time of this intrusion, and thus lent itself to extensive shattering, and the detached blocks have been melted up on an extensive scale. From analogy with undoubted composite products, the author considers that the well-known "essexite" of Salem Neck, consisting of the minerals of gabbro side by side with species more rich in sodium, has arisen from similar intermingling and recrystallisation.

PETROLEUM RESOURCES OF CALIFORNIA.—The geology and petroleum resources of North-Western Kern County, California, have been dealt with in a bulletin of the United States Geological Survey (No. 721) recently to hand. New information concerning this interesting region is always welcome, and the oil prospects of this part of the San Joaquin Valley, with its bordering hilly country, would seem to be decidedly favourable. The area described embraces the already developed fields of Belridge and Lost Hills, which produce oil from Miocene beds, the structures being essentially anticlinal; prospective areas are suggested in the Temblor Valley (hill region) and in the San Joaquin Valley itself, though in the latter instance "wild-cat" drilling will probably have to be resorted to on account of the thick covering of alluvium masking the solid geology. The detailed work of the California State Mining Bureau on the study of underground structural conditions as affecting development and production of existing fields is now in progress, and as results accrue some further valuable information should eventuate which may have a far-reaching influence on the progress of development of the untested areas here described.

DAY AND NIGHT DISTRIBUTION OF RAINFALL.—The differences between summer daytime and night-time precipitation in the United States are the subject of a communication by Mr. W. J. Humphreys in the *Monthly Weather Review* for June last. A chart based on about 175 Weather Bureau stations is given showing the percentage of average precipitation that occurs at night, 8 p.m. to 8 a.m., for the season April to September over the United States. The various percentages of the twenty-four hours' rainfall that occur at night in different portions of the United States during the summer are shown by curves for each 5 per cent. from 25 to 65. Referring to the inequalities between the day and night distribution of summer rainfall, and accepting this as due to the distribution of thunderstorms, it is stated to be consequently in substantially the same proportion as is the strong vertical convection of tolerably humid air. The map shows very markedly that in the south-east portion of the United States the summer rains are most frequent during the day, and the author states that most of these rains are due to heat thunderstorms resulting from convection induced by strong surface heating. The excess of rains in the daytime in some other parts of the United States is similarly explained. Consideration is also given to the regions in which the summer rain is most abundant by night, and various causes are put forward. The movement of cool anticyclones is asserted as exercising considerable influence in the main by "breaking" the "hot waves" of the Mississippi, Missouri, and Ohio valleys, thunderstorms being developed. In parts the cooler air is said to overflow the warmer, and thereby establishes that convectional instability essential to the genesis of the thunderstorms. In this way the author is of opinion that in parts at least the thunderstorm is more frequent and the summer precipitation more abundant during the night than during the daytime.

GRAVITY OBSERVATIONS.—The United States Coast and Geodetic Survey has issued as a Special Publication (No. 69) a report by Mr. Clarence H. Swick on "Modern Methods for Measuring the Intensity of Gravity." The instruments and methods, which are dealt with in usefully great detail, are those employed by the Survey for their gravity expeditions. The determinations are made with half-second (quarter-metre) pendulums, which in 1890 replaced the metre pendulums formerly used. This step marked an epoch in the gravity work of the Survey; the change not only greatly reduced the cost of transport and of preparing the stations, but also increased the accuracy so much as to render the observations prior to 1890 obsolete as material for investigations into the theories of gravity and isostasy. The observations made are relative, the time of oscillation of the pendulums measured at each station being compared with the corresponding times at the pendulum-room of the Survey in Washington, where the absolute value of gravity has been carefully determined. The pendulums are swung at low pressure in an airtight case, and corrections are applied for temperature, pressure, arc, flexure, etc. An interferometer is used to determine the flexure of the pendulum support. Up to 1920 the number of gravity stations "occupied" with the modern instruments was 276, of which 230 were established since 1909. In 1920 a further important instrumental improvement was introduced by the construction of pendulums with invar instead of bronze; the reduction of the temperature-coefficient to one-fifteenth its former value greatly simplifies the observing conditions. Another advance is the use of wireless signals for determining the chronometer rates. The report closes with an interesting appendix instructing the observer in the art of justifying his work to the lay citizen of the United States, by explaining briefly the purpose and value of gravity observations.

TESTS OF WELDLESS STEEL TUBING.—A paper by Mr. W. W. Hackett read before the Institution of Automobile Engineers gives an account of a large number of alternating stress experiments on weldless steel tubing such as is used in motor-cycles and on components, *e.g.* motor-cycle forks. These experiments enable the author to make several suggestions for improvements in constructional details. He also makes out a case for the use of tubes made from steel containing a higher percentage of carbon than has formerly been accepted. From experiments carried out during the war period on aeroplane tubing it was found that excellent results could be obtained by using 0·5 per cent. carbon steel tubing, giving in the bright or blued state a yield of 40 to 45 tons per sq. in. and an ultimate stress of 45 to 50 tons per sq. in.; when annealed, the steel should give 23 tons per sq. in. yield and 35 tons per sq. in. ultimate. The author has found that in the motor trade there was no inclination to use these high-carbon steel tubes, for it was feared that they would be brittle. The author's tests were carried out on joints brazed in his shops in a commercial manner, and show consistently that the 0·5 per cent. carbon steel has always been superior to 0·3 per cent. steel, and that the latter has always been better than 0·15 per cent. steel.

Botany at the British Association.

(a) *The Oldest Land Flora.*

THE Edinburgh meeting will be long remembered among botanists as that at which a consideration of the oldest land flora, namely, that of the Rhynie Chert beds, took a prominent place. This subject bulked largely in the president's address; it formed the basis of a series of papers presented to a joint meeting of the Sections of Botany and Geology, and it was fully illustrated by a marvellous series of microscope preparations demonstrated by Dr. Lang and Dr. Kidston in the laboratory of the Royal Gardens.

The Rhynie Chert beds of Devonian age contain identifiable remains of algæ, fungi, and bacteria, but the chief interest attaches to the forms which, though classified as vascular cryptogams, present in many respects little more differentiation than a seaweed, and, indeed, show many resemblances to some of the higher seaweeds of the present day. They are leafless and rootless forms bearing sporangia scarcely differentiated from the vegetative portion of the axis. Nevertheless, they are undoubted land plants, as shown by "the presence of water-conducting tissue and stomata and by manifestly air-borne spores." The function of roots was apparently performed either by root-hairs or by special branches of the rhizome. The spores were usually borne on terminal sporangia which were evidently fertile branch endings.

Dr. Lang described the plant remains found in these beds, and more particularly those of the vascular forms constituting the family of the Rhyniaceæ, viz. a filamentous alga probably allied to the modern blue-greens; another form which appears to be connected with the Characeæ; and a fragment of the supposed seaweed Hematophyton, showing for the first time its external characteristics, together with several members of the fungi. The Rhyniaceæ include *Rhynia major* and *R. Gwynne Vaughanii, Hornea Lignieri,* and *Asteromyelon Mackei,* the latter with its small investing leaves being the most complex. The vascular tissue is of a very simple order, the water-conducting elements being spirally thickened and the phloëm elements large and thin-walled with oblique ends. The latter tissue is continuous with a central column in the sporangial heads, recalling the columella of the mosses.

The vertical distribution of the various forms in the peaty beds of the chert indicates that petrifaction occurred in the lower parts of the bed while plants were still growing on the higher parts. Probably the irritating action of vapours from a volcanic fumarole in the neighbourhood caused the necroses and swellings observed on the plants.

Dr. Horne stated that recent work pointed to the Continental origin of the deposit and indicated that the Rhynie plants actually grew where they were preserved.

Dr. Kidston concluded that if Asteroxylon were flattened out and preserved as an impression it would resemble very closely the middle Devonian species called *Thyrsophyton Milleri,* and he believed that the fact afforded some indication of the Middle Old Red Sandstone age of the Rhynie bed.

Several of the later speakers directed their remarks more to the theoretical importance of these discoveries and their relation to modern theories of evolution. This had been dwelt upon at some length by Dr. Scott, who emphasised the present-day lack of unanimity with regard to the nature and extent of variation as the material upon which evolution works. Dr. Lotsy pointed out the dilemma summed up in the phrases "like breeds like" and "like may breed unlike." He thought that the great phyla were widely separated, and had possibly separate origins, and while for *classes* of plants, as generally considered by the palæobotanist, the first phrase emphasised the truth, when the smaller units or *species* were considered it was clear that frequently "like breeds unlike."

(b) *Forestry and its Problems.*

A whole day was devoted to forestry, the Botany and Zoology Sections holding joint session during the part of the programme concerned with insect problems. Mr. J. Sutherland, Assistant Commissioner for Forestry in Scotland, gave a very complete account of the past and present position of forestry in Great Britain, and enumerated in an exhaustive manner the advantages of a consistent State policy of extended afforestation. The new forestry policy now provides that the 3,000,000 acres of 1914 shall be increased during the present century by 1,750,000 acres of coniferous trees, and that two-thirds of the programme shall be completed during the next forty years. This programme cannot, however, be put into actual effect without the co-operation of landowners and State. A large proportion of money expended in forestry becomes available as wages, and consequently it provides a great stabilising influence in keeping workers in rural areas. He quoted the increase of population from 69,000 to 289,000 which has taken place in the Landes Department of France as a result of afforestation. He further indicated the immense importance of forests in time of war.

Prof. Stebbing traced the history of Indian forestry since 1850, when a committee of the British Association was set up at the instigation of Dr. Cleghorn "to consider the probable effects from an economic and physical point of view of the destruction of tropical forests in India." The result of the efficient management of the Indian Forest Department shortly afterwards set up has been a plentiful supply of forest products and a considerable annual revenue.

Dr. Borthwick and Prof. Henry both urged the importance of selecting the varieties most suitable to the climatic conditions found in the country, and expressed the opinion that the State might reasonably undertake the protection of forests from devastating fires.

(c) *Quantitative Analysis of Plant Growth.*

The discussion on "The Quantitative Analysis of Plant Growth" was introduced by Dr. Lawrence Balls, who illustrated his points largely by reference to the cotton plant. The problem of plant growth is a physico-chemical one, and therefore must be explored by quantitative methods and checked by statistical treatment. Dr. Balls hinted at the possibility of elucidating geometrical constructions in the cell parallel to those established by Dr. Church for external form. This would furnish developments akin to those which the study of atomic structure has brought to the physicists. The recent advance in physiological thought as well as in actual technique gives us reason to expect rapid increase of knowledge even in so intricate a problem as that of growth.

Contributions to this discussion were made by Messrs. Briggs, Kidd, and West on "The Quantitative Study of the Growth of *Helianthus annuus,*" and by Prof. Priestley and Miss Evershed on "A Quantitative Study of the Growth of Roots."

(d) Some other Papers.

The papers delivered before the Section dealt with a diversity of subjects. Mr. Matthews contributed a paper on "The Distribution of Certain Elements of the British Flora." These show peculiarities of geographical distribution in Great Britain which, when studied cartographically and compared with their occurrence on the Continent, seem to furnish additional evidence in favour of the views of some of the earlier students of the problems of plant repopulation after the Glacial period. The Palæarctic flora of post-Glacial times is now confined to the highest Scotch mountains, and has been replaced elsewhere in Great Britain by a temperate flora from the Continent.

Mr. Hamshaw Thomas gave an account of his investigations into the structure of some angiospermous fruits discovered in the Middle Jurassic rocks of Yorkshire. Each fruit, which shows traces of what may be a stigma, contains about eight small seeds clothed with a double fibrous integument. While the specimens are obviously Angiosperms in that the seeds are developed inside a fruit-wall, the seeds themselves show resemblances to some of the primitive Gymnosperms or Pteridosperms, and may yet throw light on the origin of the flowering plants, that difficult problem referred to by Charles Darwin as an "abominable mystery."

Prof. McLean Thompson, in his account of the floral development of the cannon-ball tree and its bearing on the floral morphology of the Myrtales, put forward the view that the gigantism of cells and sterility of pollen found associated with the floral lopsidedness had arisen as a mutation.

Dr. Batten gave an account of the organs of attachment in Polysiphonia; Miss Saunders put forward a theory of the morphological nature of the Dicotyledon shoot, viz. that each internode consists of an axial core clothed with a skin of the extended bases of the leaves immediately above.

Major Hurst's paper on "The Origin of the Moss Rose" raised many interesting problems, particularly in view of the recent cytological work on this genus. Täckholm and Blackburn and Harrison ascribe hybridity as the cause of the irregular distribution of unpaired chromosomes found to be associated with abortive pollen. Darwin's view that the moss rose is a bud variation of the familiar cabbage rose (*Rosa centifolia*) seems to be confirmed. The moss rose would appear to have arisen as a mutation, and to have been in cultivation only since the end of the seventeenth century, while the cabbage rose has been cultivated for more than two thousand years. In conclusion, Major Hurst expressed his views thus:—"In terms of the recent development of the chromosome theory of heredity it may be said that the *moss* mutation arose through the presence of an additional factor in a single locus of a single chromosome of a somatic cell."

"The Behaviour of the Somatic Nucleus in Development" formed the subject of a paper by Prof. McLean, who described briefly the discovery of the binucleate phase, and discussed its significance in relation to senescence, normal histogenesis, and somatic segregation of characters.

The eminent Dutch botanist, Dr. J. P. Lotsy, furnished a paper on "Factors of Evolution." He deprecated the custom of tracing the course of evolution through the genealogy of species which exist only as a conception. Nature produces individuals, some of which interbreed freely and may be termed "syngameons," and these have been mistaken for species. The course of evolution should rather be traced by the genealogy of the gametes, and the questions of fundamental importance are: Can a gamete vary by itself without loss of chromosomes? And are such variants transmissible? The only transmissible changes proved to occur are the results of crossing, and they transgress the limits of the Linnean species. Not enough attention has yet been given to the crosses between gametes differing in the number of chromosomes and the consequent irregular distribution which causes changes that may even simulate Mendelian segregation.

E. N. M. T.

Mont Blanc Meteorological Observations.

The seventh volume of Annales de l'Observatoire Météorologique Physique et Glaciaire du Mont Blanc (altitude 4350 metres) has now been published, under the direction of M. J. Vallot, founder and director of the observatory, following the sixth volume which was published in 1905 (tome 7, Paris, G. Steinheil, éditeur, 1917). It records the death of Janssen in 1908 and the transformation of the provisional society of his observatory at the summit (4808 metres) into a *société définitive* which placed that observatory also under the direction of M. Vallot. Both were utilised in 1908, but that on the summit became not merely uninhabitable, but dangerous, and it was therefore demolished in 1909. Since that date work has been carried on only at M. Valot's observatory, which he had placed at the disposal of the society. The volume referred to deals only with the work accomplished before the union of the observatories. The researches made at the cost of the society have been published *en résumé* in the *Comptes rendus*; those which cannot find a place there, as well as reports *in extenso*, will appear in later volumes of the Annales.

The publication of the seventh volume has been delayed by M. Vallot's ill-health and by the war. It contains two papers by M. Henri Vallot, one on some modern maps of the massif of Mont Blanc, the other on the progress made with the map on the scale of 1 : 20,000 by the brothers Vallot; also some "Notes expérimentales sur le mode d'action des cures d'altitude," by M. G. Kuss, of the Sanatorium d'Angicourt. The greater part of the volume is occupied by an elaborate discussion by M. J. Vallot of the barometric calculation of altitudes, particularly on the correction for the diurnal variation of the temperature of the air, which with the ordinary formula may cause differences of as much as a hundred metres in the estimation of a difference of level of 2800 metres. The discussion leads up to the suggestion for correcting the value of the difference of height obtained by the "classical" tables by a correction based on the mean temperature of the day for the base station, on a temperature for the upper station obtained from the base temperature by subtracting one degree for every 154·5 metres, and on a special correction for diurnal variation of temperature based on a month's observations in 1887 of Mont Blanc with reference to Geneva. Suitable winter values have still be to be ascertained. Examples of the application of the method are given and a defence of the procedure in view of recent work on the subject, which is of practical importance for meteorological maps as well as for Alpinists. It is, however, full

of difficulty in consequence of the changing thermal character of the air column between stations at different levels. Perhaps the diurnal variation of pressure affords the best line of approach. A proper formula regularly applied to observations at the top ought to give a diurnal variation of pressure at the base comparable with that obtained from direct observations at the bottom. What M. Vallot calls the "classical" method would certainly not do so. There is an interesting paper by Buchan on experiences at Ben Nevis which bears upon the subject.

NAPIER SHAW.

Sponge-spicules.

PROF. DENDY'S memoir (in *Acta Zoologica*, 1921, pp. 95–152, 50 figures) on the evolution of the tetraxonid sponge-spicule will appeal equally to those interested in problems of evolution or in sponge-spicules from the point of view of form and of their great taxonomic value. It is not only possible to arrange these spicules in an apparently phylogenetic series with a degree of completeness which is perhaps unparalleled in any other group of the animal kingdom, but the structure of the spicule itself, and the different forms which it assumes, are relatively so simple and definite that the problem of accounting for them in terms of physiological or physico-chemical processes seems far more capable of solution than similar problems among the higher animals. Prof. Dendy describes the forms of spicules of the primitive Plakinidæ, showing that they can all be derived from the tetract, and discusses concisely the evolution of megascleres (tetract, diact, and monact) and microscleres (polyact and diact) and the development of spines leading to the pseudopolyact forms. He also puts forward provisional conclusions as to the development of a spicule. Two kinds of cells—initial cells and silicoblasts—are concerned in spicule formation; the former cells secrete the organic material (spiculin) which forms the axial thread or protorhabd around which the silicoblasts collect and deposit silica. A growing spicule may come to be completely enveloped by a silicoblast, which has accordingly been regarded by nearly all observers as the mother-cell in which the spicule originates. In many cases the number of initial cells increases by cell-division as the spicule grows, and the development of spines and other outgrowths on the primary spicule is effected by the establishment of secondary growing points at the places where spiculin is deposited by initial cells. The causes which determine the form of the spicule are briefly considered, and though some of the characters of spicules are adaptive the vast majority are non-adaptive; for adaptation in spicule-form, where such exists, no satisfactory explanation seems to be forthcoming. To say that some "instinct" directs an amœboid silicoblast containing a spicule towards the gemmule or towards the surface of a sponge is, as the author remarks, not an explanation.

Iron Production in India.

THE *Journal of Indian Industries and Labour* for November last (vol. 1, part 4) contains, amongst other interesting matter, a summary of the present position of iron production in India which deserves the serious attention of all engaged in iron and steel industries. The large and rapidly developing coalfields, the enormous deposits of high-grade hæmatite iron ore, ample supplies of limestone and of refractory materials, abundant and low-priced labour, all combine to place India in the position of a very serious potential competitor in the world's markets. Two firms are producing iron to-day—the Bengal Iron Co., with works at Kulti, on the Barakar River, comprising five blast furnaces, each with an output of 450 tons of pig-iron per twenty-four hours, and the Tata Iron and Steel Works at Jamshedpur, in Singbhum, with three blast furnaces having a capacity of 900 tons of pig-iron per diem; the latter firm also possesses a steel works with seven furnaces capable of producing 17,500 tons of ingots per month, whilst extensions to both the blast-furnace plant and the steel works are in course of erection and a plate-mill has just been completed. A number of new works are being projected; the Indian Iron and Steel Co. is building blast furnaces for an output of 600 tons of pig-iron per diem at Hirapur, the Eastern Iron Co. is building blast furnaces close to the Jharia coalfield, whilst the United Steel Corporation of Asia is to establish works producing both iron and steel at Manoharpur; this last works intends to use coal from the new Karanpura coalfield. The Kirtyanand Iron and Steel Works, near Sitarampur, does not at present propose to make pig-iron, but is confining itself to the production of iron and steel castings. In connection with the Tata works a group of subsidiary concerns have been, and are being, formed at Jamshedpur to work up the iron and steel produced by these works; they comprise the Calcutta Monifieth Works (for producing machinery for jute manufacture), Enamelled Ironware, Ltd., the Tinplate Co. of India (which will supply the Burma Oil Co. and other Indian oil companies), the Agricultural Implements Co., the Indian Steel Wire Products, Ltd., the Enfield Co., and the Hume Pipe and Construction Co.

University and Educational Intelligence.

CAMBRIDGE.—The governing body of Emmanuel College offers to a research student commencing residence at the college in October next a studentship of the annual value of 150*l*., which shall be tenable for two years and renewable, but only in exceptional circumstances, for a third year. The studentship will be awarded at the beginning of October, and applications should be sent so as to reach the Master of Emmanuel (the Master's Lodge, Emmanuel College, Cambridge) not later than September 18.

The following grants from the Gordon-Wigan Fund are reported:—For plant-breeding experiments, 50*l*.; for museum cases, 35*l*.; for apparatus for studying marine organisms, 35*l*.; for the preparation of rock slices, 20*l*.; and for the preparation of sections of fossil plants, 10*l*.

The annual report of the General Board of Studies for the academic year 1920–21 refers to a distinct relief in the congestion in the scientific departments on account of the completion of new buildings. Fresh accommodation for chemistry and engineering has improved the position of affairs in those departments, and is easing it also in other departments. Several laboratories are faced with serious deficits on the year's working, and complaints are made of the effect of the 100 per cent. tax charged on certain things only procurable abroad. Valuable loans are announced of sound-ranging apparatus from the War Office and of radium from the Medical Research Council.

LONDON.—The three following courses of free public lectures are announced:—"The Crystallisation of Metals," by Col. N. T. Belaiew, at the Royal School of Mines, South Kensington, S.W.7, on Tuesdays, February 21 and 28 and March 7 and 14, at 5.30; "Some Recent Developments in Pharmacology," by Dr. H. H. Dale, at the London (Royal Free Hospital) School of Medicine for Women, Hunter Street, W.C.1, on Wednesdays, February 22 and March 1, 8, and 15, at 5; and "Certain Aspects of Fresh-water Algal Biology," by Prof. F. E. Fritch, at the East London College, on Wednesdays, February 15 and 22 and March 1, 8, 15, and 22, at 4.

OXFORD.—An examination for a natural science scholarship at Keble College is to be held on March 14. The annual value is 80*l*., with 20*l*. extra for laboratory fees. Applications should be made to Dr. Hatchett Jackson, Keble College, Oxford.

PROF. T. MATHER is retiring from the chair of electrical engineering in the City and Guilds (Engineering) College at the end of the present session after more than thirty-seven years' service in the college, first as assistant to the late Prof. Ayrton and then as his successor.

THE Association of Heads of Departments in Pure and Applied Science in Technical Institutions has forwarded a letter to the London County Council Education Committee directing attention to some anomalies arising from the revised scales of salaries following on the Burnham Report. It is pointed out that on the new scales the salaries of an assistant will rise automatically to a maximum which approximates to that of the head of a department, a state of affairs which gives an assistant little incentive to work for higher appointments involving additional responsibilities and qualifications.

A PAMPHLET entitled, "The Handicap," has been issued by the University of Glasgow as an appeal for support in an attempt to develop what may be termed the social, as opposed to the academic, side of university training in Glasgow. Benefactors in the past have contributed generously for the provision of professorships, scholarships, and laboratories—as much as 180,000*l*. has been given for such purposes during the past five years—but few have thought of providing for the well-being of the student outside the classroom. A notable exception was Dr. John M'Intyre, who, in 1889, presented a Students' Union to the university, but in spite of extensions, this building cannot accommodate more than 500 of the 3300 men students now in Glasgow. Another step towards the provision of a liberal education might be achieved by an extension of the hostel system in the hope of capturing some of the spirit of the older residential universities. At the present time hostel accommodation can be found for 40 men and 50 women, while 1016 men and 310 women students have to find such lodgings as are available in the city. It is for providing hostels and contributing in other ways to the welfare of the student that the appeal is being launched; grants and gifts amounting to some 40,000*l*. have already been promised, but it is considered that 150,000*l*. is really required. Contributions, which should be forwarded to Dr. A. E. Clapperton, secretary of the University Court, Glasgow, are therefore earnestly solicited, and it is hoped that a generous response will be forthcoming, particularly from the graduates and alumni of the university.

Calendar of Industrial Pioneers.

February 10, 1886. Edward Williams died.—First forge and mill master at the Dowlais Iron Works, South Wales, where under Menelaus he rolled the first steel rails from an ingot supplied by Bessemer, Williams was afterwards connected with the Cleveland iron trade at Middlesbrough, and for ten years was manager to Bölckow and Vaughan. He assisted in founding the Iron and Steel Institute, and in 1879–81 served as president.

February 10, 1912. Louis Delaunay Belleville died.—From the Ecole Polytechnique and the Ecole Navale Delaunay Belleville in 1867 entered the Belleville Engineering Works in Paris, and there brought out his well-known water-tube boiler for steamships. First fitted in French despatch vessels and cruisers it was afterwards extensively adopted in the French, Russian, and British Navies, allowing of the use of very high steam-pressures. Its use in our own Navy led to a vigorous controversy, and the Belleville boiler has since been superseded by others of simpler construction.

February 11, 1907. Léon Serpollet died.—A great French automobilist and a pioneer of the modern steam car, Serpollet brought out an improved form of flash boiler which in 1887 he used in a steam-propelled tri-car. Four years later he was the first to obtain authority to run his cars in the streets of Paris. His statue stands in the Rue Brunel.

February 12, 1874. Sir Francis Pettit Smith died.—The most prominent among the many inventors of screw propellers, Smith began life as a farmer. His patent was taken out in May, 1836, and during the next two years his screw was tried in the *Francis Smith* and the *Archimedes*. The success of the latter led Brunel to adopt screw propulsion for his trans-Atlantic liner, the *Great Britain*, while the Admiralty ordered the building of the H.M.S. *Rattler*, the first screw-driven man-o'-war. In 1845 the screw was adopted for all war-vessels. Smith remained Adviser to the Admiralty for a few years, and from 1860 until his death was curator of the Patent Office Museum.

February 13, 1824. Pierre Louis Guinaud died.—An improver of the manufacture of optical glass, Guinaud was a Swiss clockmaker. He was the first on the Continent to make flint-glass discs suitable for achromatic telescopes, and his success led to his co-operation for some years with Fraunhofer at Munich. Guinaud's methods were communicated by his son to Bontemps, who about 1848 was engaged by Chance, of Birmingham.

February 13, 1913. John Fritz died.—One of the great pioneers of the American steel industry, Fritz was born in Pennsylvania in 1822, his father being a native of Germany. He was intimately connected with the introduction of the Bessemer process into America, in 1857 erected the first three-high mill ever seen, and three years later became general superintendent of the Bethlehem Company. The John Fritz medal of the United Engineering Societies was founded in 1902.

February 14, 1831. Henry Maudslay died.—The founder of the firm of Maudslay, Sons, and Field, which during last century held a pre-eminent place among the builders of machinery for steamships, Maudslay, after working under Bramah, set up for himself in London, and in 1810 opened the works at Westminster Bridge Road. He patented a "table engine," built some of the earliest marine engines, constructed measuring machines, and improved machine tools. Many well-known mechanical engineers were trained in his shops. E. C. S.

Societies and Academies.

LONDON.

Royal Society, February 2.—Sir Charles Sherrington, president, in the chair.—C. **Shearer**: The oxidation processes of the echinoderm egg during fertilisation. The oxygen consumption and the carbon dioxide output of the eggs of the sea-urchin *E. microtuberculatus* during fertilisation have been measured by means of a special form of the Barcroft differential manometer. An immediate consumption of oxygen and a corresponding output of carbon dioxide take place on the sperm being added to the eggs. At the end of one minute this increase is equivalent to a rise in the metabolic rate of the egg of more than 8000 per cent. Sections of fixed material preserved during different intervals of the process of fertilisation show that this is brought about by the contact of the sperm with the external surface of the egg-membrane. The fusion of the male and female pronuclei in the later phases of fertilisation is without any influence on the curve of the oxygen consumption. The dipeptide glutathione is present in both ripe germ-cells of the sea-urchin *E. miliaris*, but one minute after fertilisation it is found in much greater quantity in the egg in reduced form, and evidence shows that it plays a very important, if not the chief, part in the oxidation processes taking place.—J. **Schmidt**: The breeding-places of the eel. The common or fresh-water eel (*Anguilla anguilla* or *A. vulgaris*) of Europe has only one breeding area, as determined by the distribution of the larvæ, situated in the western Atlantic, south-east of Bermuda. The larvæ are pelagic, and are carried to the east and north-east by the Atlantic current; their growth and the metamorphosis into the "elver," or young eel, are described; the elvers are three years old. The breeding area of the American eel (*A. chrysypa*) is south-west of that of the European eel, but overlaps it; in the American eel growth of the larvæ is much more rapid than in the European species, and the elvers are only one year old. This explains why the European eel is not found in American rivers or the American eel in Europe; if larvæ of the American eel are carried eastwards, the metamorphosis takes place in the middle of the Atlantic; if larvæ of the European eel go north or north-west, they reach the American coast two years before the metamorphosis is due.—J. **Gray**: The mechanism of ciliary movement. Pts. 1 and 2. The rate of beat of the cilia on the gills of *Olytilus edulis* can be controlled by adjusting the hydrogen-ion concentration of the cell interior. The amplitude of the beat can be controlled by an alteration in the osmotic pressure of the external medium. The cilium is essentially a bundle of elastic fibres the tension of which varies during the different phases of the beat. The activity of cilia and muscle-cells depends on similar conditions and mechanisms. The normal properties of the cell-membrane are maintained only in the presence of divalent cations. Ciliated cells are permeable to monovalent cations, but not to anions. Ciliary activity may persist when the normal semi-permeable properties of the cell-wall have been destroyed—J. S. **Huxley** and L. T. **Hogben**: Experiments on amphibian metamorphosis and pigment responses in relation to internal secretions. Salamandra and Triton larvæ may be metamorphosed by immersion in a dilute solution of iodine. Metamorphosis is retarded by low temperature; high temperature at first causes increased growth of the gills. Sexually mature Axolotls can be made to undergo rapid metamorphosis by means of a thyroid diet. Metamorphosis is accompanied by exophthalmos, apparently in all Amphibia. Iodine free of organic combination, and fresh glandular substance of the prostate and pituitary anterior lobe, are without effect on the metamorphosis of the Axolotl. Pituitary feeding produces a marked temporary dilatation, followed by excessive contraction of the dermal melanophores in albino Axolotls. Adrenal medulla extract produces, temporarily, complete contraction of the dermal melanophores in the Axolotl. Pineal administration rapidly causes a striking transient contraction of the dermal melanophores in frog tadpoles, but has no effect on the melanophores of the Axolotl. Seven months' thyroid feeding was not accompanied by any noteworthy somatic changes in Necterus.

Royal Meteorological Society, January 18.—Mr. R. H. Hooker, president, in the chair.—R. H. **Hooker**: The weather and the crops in eastern England, 1885–1921. The objects of the inquiry were: (1) To determine by the method of correlation, on the basis of the thirty-five years 1885–1919, which were the critical periods in the growth of farm crops; (2) to ascertain how far each such period was responsible for the actual crops harvested in each year. Wheat is most seriously affected by wet weather at sowing in autumn and winter, while warmth in winter is beneficial. The chief requirement of barley is a cool, dry early summer, whereas for oats the same period should be wet and cool. Turnips need rain about June, but cool weather is even more important; for hay the fundamental necessity is rain in the late spring. A cool summer is more important than rainfall for almost all crops except hay, and even that is the better for cool weather. The requirements of potatoes are practically the opposite of all other crops. For quality of seed, absence of rain, and in some cases warmth, is desirable. One feature strongly emerges, viz. that so far as regards bulk of corn the east of England is too wet (except for oats and beans) and too warm. The worst years, particularly 1893 and 1911, were due to hot, dry summers, and the same feature was the cause of the generally bad crops of 1921, though wheat, which withstands heat and drought well, was a record. As a type of a good all-round year 1902 was selected; it was characterised by prolonged cool weather throughout the spring and summer, accompanied by rain until June, and followed by dry weather. In the east of England 1920 had a cool summer, only partly spoilt by rain in July, and the resultant crops were mostly good. The fifteen years 1895–1910 were mostly a period of good crops, but in the last seven or eight years there have been a succession of very unfavourable weather conditions, notable chiefly for dry, warm springs.

Geological Society, January 18.—Mr. R. D. Oldham, president, in the chair.—A. C. **Seward** and R. E. **Holttum**: Jurassic plants from Ceylon. The plant-impressions are from a shale resting upon Archæan rocks at Tabbowa, in the North-Western Province of Ceylon. These are the first fossil plants recorded from the island. The plant-bearing beds coincide, both in the composition of the flora and in their relation to the older igneous rocks, with those of Madras.—F. S. **Wallis**: The Carboniferous Limestone (Avonian) of Broadfield Down (Somerset). Lithologically and palæontologically the area holds an intermediate position, and forms a link, between the developments of the Bristol and the Mendip districts. A well-marked faunal assemblage is described from the top of S_1. It constitutes a very useful field determination of the datum-line between the S_1 and S_2 sub-zones. *Pustula elegans* (M'Coy) from the S_1 sub-zone and the sub-zones Z_1 and D_1 are recorded for the first time from this area.

Linnean Society, January 19.—Dr. A. Smith Woodward, president, in the chair.—A. B. **Rendle**: Specimen of wood of *Orites excelsa*, R. Br. (family Proteaceæ), one of the Australian silky oaks. The tree, which is a native of northern New South Wales and Queensland, is of unique interest from the deposits of aluminium succinate which occur in cavities of the wood. Aluminium is very rarely found in flowering plants, and only in small traces; but *Orites excelsa* absorbs alumina from the soil in large quantities, as shown by analysis of the ash. Occasionally the amount taken up is excessive, in which case the excess is deposited in cavities as a basic aluminium succinate.—E. Marion **Delf** and Miss M. M. **Michell**: Studies in *Macrocystis pyrifera*. After describing the distribution of the alga, the authors reviewed recent accounts of it. The fertile fronds are completely submerged, smooth, dichotomously branched, and usually borne on special shoots. They bear sori on both sides of the frond. Exceptional cases were described of discontinuous sori occurring in the grooves of fronds with wrinkled surface and borne on the long swimming shoots, and usually without a swim bladder at the base. The zoospores do not appear to have been previously described. Material brought from the shore in the morning and examined in the laboratory in the evening showed swarming zoospores, the next morning swimming actively, and more slowly. The authors consider that the species occurring at the Cape is *Macrocystis angustifolia*, Bory, from its rhizome-like attachments.—J. L. Chaworth **Musters**: The flora of Jan Mayen Island. The flora of Jan Mayen may be divided into four main groups. The floras of the seashore, of the bird-cliffs, of sheltered places in the "tundra," and the mountain flora. The most luxuriant flora, which consists of Taraxacum or Oxyria, grows either under the bird-cliffs or in places where tuff has been re-assorted by water. The limit of flowering plants seems to be about 3000 ft. The total phanerogamic vegetation consists of about forty-three species, all of which are common to both Norway and East Greenland. The origin of the flora presents a very complicated problem. Seeds have probably been brought there on the feet of wading birds which migrate to and from their breeding-grounds in East Greenland. It is highly improbable that Jan Mayen has ever been connected with either Iceland or Greenland. Many plants have probably reached Jan Mayen during very recent years.

PARIS.

Academy of Sciences, January 23.—M. Emile Bertin in the chair.—The president announced the death of M. Camille Jordan, member of the Academy.—D. **Riabouchinski**: Some considerations on the form of the solid and the kinetic energy of the fluid which surrounds it.—A. **Perot**: The variation in the wave-length of the telluric lines. From measurements made in 1914 and in 1920–21 on the atmospheric lines of the B group the wave-length has been found to vary with the height of the sun above the horizon, nearly proportional to the sine of the angle. The hypothesis that the variation of the wave-length as measured was caused by an unsymmetrical widening of the line has been examined and rejected as insufficient to explain the observed facts.—H. **Colin** and Mlle. A. **Chaudun**: The law of action of sucrase: the velocity of hydrolysis and the reaction of the medium. It is well known that the activity of the hydrolysing diastases, especially sucrase, depends on the acidity of the medium. Results are given of the velocities of inversion of cane-sugar by sucrase in solutions of varying alkalinity and acidity. The velocity of inversion attains a maximum for a given acidity, and then falls off with further additions of acid. The addition of acid corresponds with a diminution of the quantity of the enzyme taking part in the reaction. The apparent immobilisation of a part of the diastase is most readily explained by the hypothesis of the formation of a sugar and enzyme complex of a physical nature.—C. F. **Muttelet**: A new method for the detection of coco-fat in butter. The cholesterol and phytosterol are precipitated by digitonin and converted into acetates. The cholesterol acetate melts at 113·6° to 114·2°, the phytosterol acetate at 125°, and mixtures at intermediate temperatures.—P. **Lemoine** and R. **Abrard**: The existence of the Upper Cretaceous in the central cavity of the Channel from the dredgings of the *Pourquoi Pas?* A map of the Channel is given showing the points at which soundings have been taken and distinguishing between spots where Cretaceous deposits have been obtained and spots where the specimens of rocks do not belong to that period. The deposits from the bottom of the central cavity (*fosse centrale*) clearly belonged to the Cretaceous period.—L. **Dussault**: The geology of the province of Sam Neua (Eastern Haut Laos).—R. **Bourret**: The massifs of the north-east of Tonkin.—P. **Russo**: The structure of the Trias of the regions of Meknés, Innaouen (northern Morocco).—S. **Stefanescu**: The practical and phylogenetic importance of the T_n of the molars of mastodons and elephants.—A. **Allix**: Observations on relief sculpture by ice. An account of the direct study of rock erosion by ice in the large crevasses of Mont Pelvoux. The views of W. D. Johnson and of B. Stracey on rock erosion by ice action are confirmed.—G. **Dubois**: Modifications of the seashore at Sangatte resulting from the storms of December, 1921.—L. **Besson** and H. **Dutheil**: The displacement of rises and falls of the barometer and the direction of movement of cirrus clouds.—R. **Combes**: The formation of anthocyanic pigments. A criticism of recent communications on this subject by Kurt Noack and St. Jonesco. The colouring matters obtained by these authors are regarded as derived from phlobatannins, and not from γ-pyronic pigments: a red coloration with alkalis is not sufficient proof of the presence of an anthocyanic pigment.—G. **Hamel**: The algæ of Rockall. In June, 1921, the Island of Rockall, 240 miles north-west of Ireland, was visited by the *Pourquoi Pas?*, and M. Le Conte and three sailors effected a landing and secured specimens of the algæ. The only brown alga was *Alaria esculenta*: neither Fucus nor Laminaria were noted.—E. **Chemin**: The parasitism of *Sphacelaria bipinnata*.—W. **Koskowski**: The action of histamine on the secretion of the gastric juice in pigeons. Histamine is not destroyed in the blood, and is not transformed in the blood into a substance stimulating the gastric secretion, but it undergoes this transformation in other tissues, principally in the skin.—C. **Levaditi** and S. **Nicolau**: A pure cerebral vaccine: its virulence for man. Vaccine virus, cultivated in the brain of the rabbit for eight months (110 passages), retains its affinity for the human skin. It produces normal vaccination without any complications, and has the advantage over ordinary vaccine of being absolutely pure without the addition of antiseptics.—A. **Donatien** and R. **Bosselut**: Acute contagious encephalitis of the ox. In 1921 a contagious disease caused the death of nine cattle in the neighbourhood of Algiers. Some of the symptoms suggested rabies, but this was proved not to be the case. The disease was transmissible to cattle, rabbits, and guinea-pigs, and was proved to be neither rabies nor Aujesky's disease. It appears to be new, and is being further studied.

Official Publications Received.

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st December, 1920. Pp. 29. (Kingston, Jamaica: Department of Agriculture.)

Straits Settlements. Annual Report on the Raffles Museum and Library for the Year 1920. By Major J. C. Moulton. Pp. ii+21. (Singapore.)

Indian Science Congress. Handbook for the Use of Members attending the Ninth Meeting to be held at Madras from the 30th of January to the 4th of February, 1922. Pp. x+165. (Madras: Capt. Clive Newcomb, Chemical Examiner.)

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September, 1921. Pp. 20. (Bristol.)

Canada. Department of Mines: Geological Survey. Bulletin No. 33, Geological Series, No. 40. Pp. ii+85+12 plates. Memoir 125. No. 107. Geological Series: Sedimentation of the Fraser River Delta. By W. A. Johnston. Pp. iv+46+maps. Geological Survey, Summary Report, 1920, Part D. Pp. 87+maps. (Ottawa.)

Iowa Geological Survey. Vol. 27: Annual Report, 1916, with accompanying Papers. Pp. viii+568+12 plates+maps. (Des Moines.)

Annuario Publicado pelo Observatorio Nacional do Rio de Janeiro. Paro o Anno de 1922. Anno 38. Pp. xiv+443+plates. (Rio de Janeiro: Ministerio da Agricultura, Industria e Commercio, 1921.)

The Geology of the Country Surrounding Johannesburg: An Explanation of Sheet 52 (Johannesburg). By Dr. E. T. Mellor. Pp. 50. (Pretoria: Geological Survey.) 5s., including map.

Report on the Crocodile River Iron Deposits. By P. A. Wagner. (Memoir No. 17.) Pp. 70+1 plate. Pretoria: Geological Survey.)

Museums of the Brooklyn Institute of Arts and Sciences. Report upon the Conditions and Progress of the Museums for the Year ending December 31, 1920. By W. H. Fox. Pp 62. (Brooklyn, N.Y.)

Smithsonian Institution: United States National Museum. Bulletin 117: The Distribution of Bird Life in the Urubamba Valley of Peru. A Report on the Birds Collected by the Yale University-National Geographic Society's Expeditions. By F. M. Chapman. Pp. 138+9 plates. (Washington: Government Printing Office.)

Cornell University: Agricultural Experiment Station. Memoir 38: The Crane-Flies of New York. Part 2: Biology and Phylogeny. By C. P. Alexander. Pp. 691-1133. Memoir 39: The Genetic Relations of Plant Colours in Maize. By R. A. Emerson. Pp. 156 +11 plates. (Ithaca, N.Y.: Cornell University.)

Papers of the Peabody Museum of American Archæology and Ethnology, Harvard University. Vol. 9: A Maya Grammar, with Bibliography and Appraisement of the Works Noted. By Alfred M. Tozzer. Pp. xvi+301. (Cambridge, Mass.: Peabody Museum.)

Department of the Interior: Bureau of Education. Bulletin, 1920, No. 34: Statistics of Universities, Colleges, and Professional Schools, 1917-18. Prepared by the Statistical Division of the Bureau of Education under the Supervision of H. R. Bonner. Pp. 223. (Washington: Government Printing Office.) 20 cents.

Department of the Interior: United States Geological Survey. Bulletin 706: The Iron Ore Resources of Europe. By Max Roesler. Pp. 152+19 plates. Bulletin 714: Mineral Resources of Alaska. Report of Progress of Investigations in 1919. By A. H. Brooks and others. Pp. 244+7 plates. Bulletin 725-A: Deposits of Chromite in California, Oregon, Washington, and Montana. By J. S. Diller and others. Pp. viii+84+5 plates. Bulletin 725-B: Chrome Ores in Pennsylvania, Maryland, and North Carolina. By E. B. Knopfe and J. V. Lewis. Pp. iv+85-139+plate 6. Bulletin 725-C: Deposits of Manganese Ore in Montana, Utah, Oregon, and Washington. By J. T. Pardee. Pp. viii+141-243+plates 7-10. Bulletin 725-D: Contact-Metamorphic Tungsten Deposits of the United States. By F. L. Hess and E. S. Larsen. Pp. vi+245-309+plates 11-14. Bulletin 726-B: Geology of the Cement Oil Field, Caddo County, Oklahoma. By F. Reeves. Pp. iv+41-85+plates 6-12. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 471: Surface Water Supply of the United States. 1918. Part 1: North Atlantic Slope Drainage Basins. Pp. 183+2 plates. Water-Supply Paper 476: Surface Water Supply of the United States. 1918. Part 6: Missouri River Basin. Pp. 266 +2 plates. Water-Supply Paper 490-B: Routes to Desert Watering Places in the Mohave Desert Region, California. By D. G. Thompson. Pp. viii+269+13 plates. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Mineral Resources of the United States in 1920. (Preliminary Summary.) Introduction by G. F. Loughlin. Pp. 123. (Washington: Government Printing Office.)

Records of the Indian Museum. Vol. 21: Catalogue of the Planorbidæ in the Indian Museum (Natural History), Calcutta. By Louis Germain. Part 1. Pp. ii+80. (Calcutta: Zoological Survey.) 2 rupees.

Diary of Societies.

THURSDAY, FEBRUARY 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Napier Shaw: Droughts and Floods (2).

HARVEIAN SOCIETY OF LONDON (at St. Mary's Hospital, Paddington), at 4.30.—Clinical Meeting.

ROYAL SOCIETY, at 4.30.—Sir J. A. Ewing: The Atomic Process in Ferromagnetic Induction.—Prof. J. W. Nicholson: Problems relating to a Thin Plate Annulus.—Prof. T. H. Havelock: The Effect of Shallow Water on Wave Resistance.—R. H. Fowler and S. N. H. Lock: The Aerodynamics of a Spinning Shell. Part II.—F. P. Pidduck: The Kinetic Theory of a Special Type of Rigid Molecule.—J. E. Jones: The Velocity Distribution Function and the Stresses in a Non-uniform Rarefied Monatomic Gas.—H. Bateman: The Numerical Solution of Linear Integral Equations.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—H. Hilton: Conics on the Pseudo-sphere.—W. F. D. MacMahon: The Design of Repeating Patterns in Euclidean Space of 3 Dimensions.—G. H. Hardy and J. E. Littlewood: Dirichlet's Series with a Barrier of Singularities.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—E. J. Kingston-McCloughry: The Design of Modern Water-turbines.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Annual General Meeting.—F. W. Preston: The Structure of Abraded Glass Surfaces.—A. J. Dalladay and F. Twyman: The Stress Conditions Surrounding a Diamond Cut in Glass.—Lt.-Col. J. W. Gifford: A Supplementary Note on Achromatic One-Radius Doublet Eyepieces.—F. Twyman and A. J. Dalladay: Change in Refractive Index at the Surfaces of Glass Melts.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Sir Ernest Rutherford: Artificial Disintegration of Elements.

INSTITUTE OF METALS (London Section) (at Sir John Cass Technical Institute, Jewry Street, E.C.3), at 8.—R. T. Rolfe: Gun-metal.

SOCIETY OF ANTIQUARIES, at 8.30.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. F. Buzzard: Some Varieties of Traumatic and Toxic Ulnar Neuritis.

FRIDAY, FEBRUARY 10.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Annual General Meeting.—Dr. E. A. Owen and Bertha Naylor: The Measurement of the Radium Content of Sealed Metal Tubes.—Sir William Bragg: The Crystal Structure of Ice.—Dr. K. Grant: A Method of Exciting Vibrations in Plates, Membranes, etc., Based on Bernoulli's Principle.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Anniversary Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. C. Pannett: Hydronephrosis (Hunterian Lecture).

KING'S COLLEGE ENGINEERING SOCIETY (Anniversary Meeting) (at Institution of Civil Engineers), at 5.30.—F. W. Macaulay: Water Engineering.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

MALACOLOGICAL SOCIETY (at Linnean Society), at 8.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—Questions and General Discussion.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Miss I. C. Mann: The Morphology of Certain Developmental Structures associated with the Upper End of the Choroidal Fissure.—Dr. H. J. May and F. A. Williamson-Noble: Three Cases of Choroidal Sarcoma, with Notes on the Microscopic Appearances.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. D. Halliburton: The Teeth of the Nation.

MONDAY, FEBRUARY 13.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—Lt.-Col. M. N. MacLeod and A. R. Hinks: Stereographic Survey.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. V. Z. Cope: The Nerve-supply of the Parietal Peritoneum and the Subperitoneal Tissues, with Remarks on its Clinical Significance (Arris and Gale Lecture).

ROYAL SOCIETY OF MEDICINE (War Section), at 5.30.—Lieut.-Colonel C. R. Sylvester-Bradley: Stature in relation to Physical Fitness.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8.30.—Prof. H. Hartmann: Inflammatory Strictures of the Rectum.

TUESDAY, FEBRUARY 14.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Variable Stars (3); Our Sun.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 4.30.—Dr. H. H. Dale and Major C. E. White: An Experimental Method of Determining the Therapeutic Efficiency of "914" Preparations.—Dr. R. L. Mackenzie Wallis: Tests for Hepatic Insufficiency after Arseno-benzol Treatment.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Prof. The Svedberg: (1) The Relation between Sensitiveness and Size of Grain in Photographic Emulsions (Part 2); (2) The Reducibility of the Individual Halide Grains in a Photographic Emulsion.—Dr. S. E. Sheppard and A. P. H. Trivelli: Note on Prof. Svedberg's Method of Grain Analysis of Photographic Emulsions.—K. C. D. Hickman: An Optical Method of Testing Washing Devices.

QUEKETT MICROSCOPICAL CLUB, at 7.30 (Annual General Meeting).—Dr. A. B. Rendle: Presidential Address.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. G. Elliot Smith: The Brain of Rhodesian Man.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. Helen Boyle: The Ideal Clinic for the Treatment of Nervous and Borderland Cases.

WEDNESDAY, FEBRUARY 15.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. C. Singer: Recently Discovered Inscriptions recording Ancient Cures.—Dr. F. G. Crookshank: The "Trousse-galland."—Dr. H. D. Davis: A Very Early Illustration of a Skin Disease.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. F. W. Edridge-Green: New Researches in Colour-vision (Arris and Gale Lecture).

ROYAL SOCIETY OF ARTS, at 8.—Cloudesley Brereton: The Necessity of Speech Training, and the Need of a National Conservatoire.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Prof. B. L. Bhatia: Freshwater Ciliate Protozoa of India.—A. L. Booth: The Microstructure of Coal from an Industrial Standpoint.—Capt. F. Oppenheimer: A Portable Microscope

THURSDAY, FEBRUARY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. G. Perkin: Dyeing: Ancient and Modern (1).

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Prof. L. Hill, D. H. Ash, and J. A. Campbell: The Heating and Cooling of the Body by Local Application of Heat and Cold.—Prof. J. B. Cohen, C. H. Browning, R. Gaunt, and R. Gulbransen: Relationships between Antiseptic Action and Chemical Constitution, with Special Reference to Compounds of the Pyridine, Quinoline, Acridine, and Phenazene Series.—D. T. Harris: Active Hyperæmia. —B. B. Sarkar: The Depressor Nerve of the Rabbit.—Prof. A. Lipschütz, Dr. B. Ottow, C. Wagner, and F. Bormann: The Hypertrophy of the Interstitial Cells in the Testicle of the Guinea Pig under Different Experimental Conditions.

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ROYAL METEOROLOGICAL SOCIETY, at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Sqdr.-Ldr. C. F. A. Portal: Methods of Instruction in Aeroplane Flying.

INSTITUTION OF MINING AND METALLURGY (at Geological Society of London), at 5.30.—J. M. Bell: The Occurrence of Silver Ores in South Lorrain, Ontario, Canada.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—F. P. Whitaker: Rotary Converters, with Special Reference to Railway Electrification.

CHEMICAL SOCIETY, at 8.—A. Lapworth: A Theoretical Derivation of the Principle of Induced Alternate Polarities.—W. O. Kermack and R. Robinson: An Explanation of the Property of Induced Polarity of Atoms and an Interpretation of the Theory of Partial Valencies on an Electronic Basis.

SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, W.C.2), at 8.—E. B. Turner: Sex Relationships.

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ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Swale Vincent: A Critical Examination of Current Views on Internal Secretion (Arris and Gale Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—A. T. Wall: Electric Welding applied to Steel Construction, with Special Reference to Ships.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—W. J. Leaton: Water Purification for Boiler Feed Purposes.

SOCIÉTÉ INTERNATIONALE DE PHILOLOGIE, SCIENCES ET BEAUX-ARTS (Celtic Section) (at 8 Taviton Street, W.C.1), at 8.—Dr. W. J. E. Scott: The Mines of El Dorado: an Historical Account of the Maritime Trade of Spain with Ireland, 2000 to 700 B.C. (2).

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ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. D. S. M. Watson: History of the Mammalian Ear.

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PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

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KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (4). —M. Beza: Nereids in Roumanian Folk-lore.

TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at the Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (3).

ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN (Leicester Square, W.C.2), at 6.—Dr. W. Griffith: The Skin Eruptions of Syphilis (Chesterfield Lecture).

FRIDAY, FEBRUARY 10.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (4).

SATURDAY, FEBRUARY 11.

LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (4).

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Domestic Life of the Ancient Egyptians.

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CITY OF LONDON (BOYS') SCHOOL (Victoria Embankment), at 5.30.—Miss Rosa Bassett: The Dalton Plan of Self-education (2).

KING'S COLLEGE, at 5.30.—Dr. J. S. Steppat: Recent Developments in German Education and Student Life (4).—Prof. C. L. Fortescue: Wireless Transmitting Valves (4).

TUESDAY, FEBRUARY 14.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 6.—Sir Josiah C. Stamp: The Administrative Factor in Government (1).

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EAST LONDON COLLEGE, at 4.—Prof. F. E. Fritch: Certain Aspects of Freshwater Algal Biology (1).

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. L. D. Barnett: The Jains.

HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (4).

UNIVERSITY COLLEGE, at 8.—The Current Work of the Biometric and Eugenics Laboratories (1).—Prof. Karl Pearson: Side-lights on the Evolution of Man: From the Knee-joint.

THURSDAY, FEBRUARY 16.

UNIVERSITY COLLEGE, at 5.15.—Prof. J. E. G. de Montmorency: Welsh and Irish Tribal Customs (2).

KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (5).—M Beza: Nereids in Roumanian Folklore (2).

ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN (Leicester Square, W.C.2), at 6.—Dr. W. K. Sibley: Seborrhœa and Psoriasis (Chesterfield Lecture).

FRIDAY, FEBRUARY 17.

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KING'S COLLEGE, at 5.—Prof. R. Robinson: Orientation and Conjugation in Organic Chemistry from the Standpoint of the Theories of Partial Valency and of Latent Polarity of Atoms (2).

UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (2).

TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (4).

SATURDAY, FEBRUARY 18.

ROYAL SOCIETY OF ARTS, at 10.30 a.m.—Prof. J. A. Thomson: The Migration of Birds (Lectures for Teachers).

LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (5).

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: A Botanist in South Africa.

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Research and Education in the Geddes Report.

THE first and second sections of the interim Report of the Committee on National Expenditure, presided over by Sir Eric Geddes, were published on February 10 (Cmd. 1581, 4*s.* net; Cmd. 1582, 3*s.* net), and the particulars of expenditure and proposed economies in the various supply services are receiving much public attention. Throughout the Report reductions are recommended in expenditure on education and research, on the general principle that the reduced resources of the nation at the present time make all possible economies essential. Thus we have such sweeps of the axe as:—Research for Army purposes to be reduced from 625,000*l.* to 312,000*l.*; Naval scientific services (400,000*l.*) to one-half; aviation research from 1,500,000*l.* to 500,000*l.*

The attitude of the Committee towards education and research, which is disclosed in the supercut of 18,000,000*l.* in the Board of Education Vote, is dominated by the narrow commercial view of goods to be delivered for money expended. The contemptible sum doled out to agricultural education and research before the war, when compared with the amounts spent in foreign countries—notably in the United States—was notorious. During the post-war reconstruction, as we noticed at the time, important administrative reforms were introduced, directed mainly to the future recruitment of the best scientific talent, which justified the hope that this country would regain the pre-eminence in agricultural science which it once enjoyed. In England and Wales the cut proposed involves a drop from 365,000*l.* to 250,000*l.*; in Scotland from 112,000*l.* to 62,000*l.* In the former case the provision for research is reduced from 109,000*l.* to 75,000*l.*, and if carried out literally will involve the dismissal of staff holding pensionable posts, and, possibly, the abandonment of land and buildings specially equipped for scientific purposes.

In some respects these recommendations are as astonishing as any contained in the report; for under the provisions of the Corn Production (Repeal) Act of 1921—passed, be it noted, after the economy campaign was begun—a sum of 1,000,000*l.* was voted for *additional* expenditure on agricultural education and research. It would almost seem that the Committee, which professes to exclude this sum from consideration, has deliberately aimed at opening an abyss into which this million shall disappear. For it should be noted that, in terms, the cut includes the Development Fund, and as that fund is almost on its last legs (the balance now in hand will little more than suffice for one year's normal requirements), the operation suggested is one which, in the vernacular of some members of the Committee, is known as "taking the breeks off a Highland man." Even if the Development Commissioners, in the exercise of the discretion which the Committee leaves them, use the Corn Production Fund to fill the gap created in the old fund, the remedy would be temporary only, and, in any event, would create the anomaly of giving preferential treatment to agricultural education and research. What does business acumen think of adding a top story to a building and at the same time destroying the ground floor?

The activities of the Forestry Commission are threatened with extinction by the Report, which recommends that the scheme of afforestation by the State shall be discontinued, that the vote of 275,000*l.* for the ensuing financial year shall not be allowed, and that steps should be taken to cancel the remaining 2,822,000*l.* of the 3,500,000*l.* authorised for the decade following 1919, the date of the Forestry Act. In the Report no complaint is made about the work or the administration of the Forestry Commission. It simply says: "We recognise the enthusiasm and public spirit of the Commissioners, but in the present state of the country's finance we cannot recommend that this expenditure—which will always show a heavy loss, and which cannot reach full fruition for something like eighty years—should be continued."

Foresters believe that afforestation will show a

profit rather than a loss, but this is not the real issue. The Committee ignores the main argument for afforestation in Great Britain—namely, national security. This country, without an adequate supply of timber within its own shores, is exposed to great peril in time of war. During the Great War the expenditure incurred on foreign timber was 200,000,000*l*. more than if the prices of 1913 had prevailed, and the enormous cargo space needed for such a bulky import endangered our food supply from overseas, and at one time brought us to the brink of starvation. The insurance against such a calamity—350,000*l*. annually—is a trifle. No heed is given in the Report to the cheapness of the afforestation, which is carried out in many cases on leased land, no capital expenditure for land purchase being required. The Government in November last actually allotted to the Forestry Commission an extra 250,000*l*. out of the Unemployment Fund, which puts 5000 idle men at work in replanting the woodland areas felled during the war. The Forestry Commission has acquired large areas of land; it has entered into many leases and contracts; it owns millions of seedling trees ready for transplanting; it has established schools for woodmen and instituted research. It is evident that the "scrapping" of such an efficient service would result in an immediate great loss of money and be a waste rather than an economy.

The section of the Report dealing with education is of special interest in so far as it carries to extreme limits that separation between the finance of education and education proper which is the characteristic tendency of the business man of to-day when he considers such matters. The obvious danger of this tendency is that finance comes to be looked upon as the only thing which matters in education, and this danger is particularly exemplified in the Report.

It should be clearly understood that the Report is the product of business men accustomed to deal with affairs on a large scale, especially in respect of railways and shipping. They are men who have made their reputation mainly in transport services, but apparently know little or nothing about education from the inside, and, so far as we are aware, make no claim to any expert or special knowledge of the subject. For example, their recommendation that children should not be taken into State-aided schools until they have reached the age of six is based, as they are careful to explain, upon the opinion of others. Obviously they do not pretend to understand the educational bearing of the question, and wisely throw the onus upon others whom, still more wisely, they carefully omit to name.

All the same, we naturally expect them to show a masterly grasp of finance, and we are not disappointed. They handle figures running into hundreds of millions with an ease and freedom and a dexterity which cannot but provoke our admiration. Occasionally—but only occasionally—they lose their balance and their business acumen, and, in their desire to cut down the Estimates, suggest proposals which would actually increase the public cost of education. A flagrant instance of this is their recommendation to withdraw Parliamentary grants from a certain type of secondary school, regardless of the fact that local education authorities have helped to support such schools "because it was cheaper for them to do so than to set up secondary schools of their own." Even a committee of business men can be too solicitous of the Exchequer!

In the main, then, as regards education, the Report deals with finance, and only incidentally or by implication with education *per se*. The task of the Committee is to cut down the Estimates, and the net result of the proposals, if adopted, would be, as we have said, to reduce the education grant by 18,000,000*l*. This is to be achieved by reducing the salaries of teachers and making them contribute 5 per cent. of their reduced salaries for superannuation purposes; by increasing the number of pupils for each teacher in elementary schools; by limiting the number of those granted free secondary education; by a reduction in the number of scholarships; by discontinuing the State scheme of scholarships at the universities; and by cutting down the annual grant to the universities. In addition, the Committee recommends the abolition of the percentage grant system, which it characterises as a money-spending device. "The vice of the percentage grant system," so runs the Report, "is that the local authority, which alone can really practise economy in these services, loses much of its incentive to reduce expenditure, especially when the larger proportion is paid by the taxpayer through the Exchequer." As a substitute, fixed grants or grants based on some definite unit are recommended. In this way the Committee hopes that the local education authorities will be discouraged from spending money on education, and is not ashamed to avow this. No charge of wanton waste or of useless expenditure is laid against local authorities.

The danger of dissociating the finance of educa-

tion from education is obvious when a Committee can make such drastic proposals without giving some assurance that the recommendations would not reduce national efficiency. It may be easy to deal with educational finance on the shipping and railway plan, but it is not possible to deal with education on the same plan. Education means something bigger than business accountancy. It means knowledge, vision, a sense of humanity, and some recognition of the spiritual aspects of civilisation.

Apart from considerations such as these, Sir Eric Geddes and his Committee have made one or two cardinal blunders. Even as business men they have shown themselves singularly short-sighted. To deprive the universities of 300,000*l.* a year may relieve the income tax of one-twentieth of a penny for the moment, but in the long run the effect will be disastrous. This is just the sort of policy which cripples the nation in the higher reaches of commerce and industry. Similarly, as business men they ought to know that, in a profession such as teaching, in which the financial rewards at the best are meagre compared with those in other walks of life, there is a salary limit below which it is impossible to recruit the profession with men. During the past twenty years the statistics show a serious relative decline in the number of men teachers. If the proposals of the Committee are adopted, the decline will be still more serious. In another respect the Committee seems to us to have gone astray. Its proper function was not to show how to reduce the quantum and efficiency of education, but rather to demonstrate how these could be maintained, if at all possible, at a lower cost to the country, and it has failed to do this.

On the other hand, we are not disposed to maintain that our educational system is flawless, or that it cannot be administered with greater efficiency and at less cost. Undoubtedly there could be a saving all round, and one might very reasonably begin with the Board of Education itself, which, to a large extent, seems to have escaped the financial criticisms of the Committee. Nor are we disposed to take too seriously the Committee's observations regarding the impotence of this Board, which has hitherto shown no great anxiety to limit its own powers.

Fortunately, however, another and wider tribunal will decide upon the larger questions of policy involved in the Report, and, in the light of knowledge and criticism, determine the value or otherwise of the recommendations. There is little doubt as to the verdict; most assuredly these recommendations will not be endorsed in their entirety by Parliament or by the more thoughtful section of the community outside Parliament. National efficiency and progress must be the first consideration, and any action which would lower the standard of either of these may be immediate retrenchment, but would not be economy.

The Supply of Gaseous Fuel.

Modern Gasworks Practice. By Alwyne Meade. Second edition, entirely rewritten and greatly enlarged. Pp. xii + 815. (London: Benn Bros., Ltd., 1921.) 55*s*.

AMONG the many truths brought home to the country by the two national struggles in which it has recently been engaged, the importance of the coal distillation industry stands out conspicuously. The rational treatment of coking coal by such means before its combustion (a process which has been carried out in our chief cities for more than a century) provided during the world war enormous quantities of material for belligerent use. It was no less effective as an instrument of social peace during the coal war, for our town-dwellers of all classes throughout the length and breadth of the land satisfied much of their requirements for the cooking of food, and in most cases for lighting their homes, by a mixture consisting chiefly of the lightest of the common gases, hydrogen, fortified with carbon in various combinations, produced in the main by the direct or indirect gasification of coal. Its centrally organised provision has now become a necessity of modern life in all our towns and most of our villages, just as are those for the supply of water and electric energy, and for the disposal of sewage. These have been almost wholly developed as engineering problems, though in the three latter cases the mathematician and the chemist, the physicist and the bacteriologist, have from time to time laid down certain principles to be followed. It will not, however, be denied that the finger of science was too often disregarded in working out the processes ancillary to the production of town's gas, and it is interesting, therefore, to observe that a change of this attitude is indicated in the pages of this latest work upon the subject.

In this exhaustive compilation, profusely illustrated with diagrams and working drawings, the technologist's debt to science, whether in the compounding of refractories or their usage, the composition of the coal or of its treatment in the cold

or by heat with the view of obtaining the highest yields in products, is fittingly acknowledged. The general public is becoming aware that there is in progress a complete revolution in the computation of gas charges, arising out of Sir George Beilby's suggestion that thermal value be substituted for mere volume as their basis (a therm of 100,000 B.Th.U. constituting the standard). A curious commentary upon these proposals is that they were carried only in the face of considerable opposition on the part of the administrators of gas undertakings. In Mr. Meade, however, they find a doughty champion whose support for them in the volume under review proclaims a teaching as sound as his practice is progressive. It is, however, unlikely that his doubt as to the intention of the gas referees substantially to prescribe the installation of continuously recording calorimeters is well founded. This body of men of science (among whom is Prof. C. V. Boys), now entrusted with the regulation of gas supplies, would probably be the last to admit that the design of such instruments offers insuperable obstacles, or that their use is not at least as necessary as the recording voltmeters of the suppliers of electric energy.

The nickel process for the purification of the finished gas from carbon disulphide by its conversion to hydrogen sulphide with subsequent removal by iron oxide is discussed in conjunction with other proposals for effecting this widely sought object. The nickel process, which it has taken something like ten years to bring to its present condition, has now become almost a complete replica of the experimental laboratory apparatus used by the late Prof. Vernon Harcourt. The general attitude towards gas lighting might have been a very different one had an earlier generation of gas engineers examined with a more intelligent sympathy the proposals of this chemist. A town's gas yielding on combustion only carbonic acid and water (such as to-day appears possible) would have occupied another *rôle* in the lighting of our houses than that furnished by the variable mixtures of gaseous combustibles with more or less deleterious diluents and sulphur-compounds endured by a long-suffering public with patience during the war.

The author uses the therm expression freely throughout his pages, and his calculations of efficiencies have thus an added value, especially those of the yields of the several systems of gasification. The importance of such a basis of comparison had been frequently overlooked until Sir Dugald Clerk drew forcible attention to it in discussing the relative values of the conversion of coal into electric and gaseous energy.

The author rightly classes naphthalene and cyanogen as impurities, not because they influence the products of combustion, but because of their harmful effect upon distributing systems. The work of Dr. J. S. G. Thomas upon the vapour tension of naphthalene finds its appropriate place in the chapter devoted to hydrocarbons, and the influence of this research upon the methods adopted for dealing with the difficulty is another instance of the value of scientific investigation in the laboratory as a guide to the large-scale practice of industry. Indeed, the most encouraging aspect of the volume under review is not only that a practical man has produced it, but that it has been produced for his practical *confrères*. Naturally consulting it for its wealth of technological information, they cannot fail to be impressed with the fact that each of the processes, in which as technicians they are interested, is shown to depend upon a foundation of science. Mr. Meade has thrown himself into his task with enthusiasm and has produced a compendium invaluable to those concerned in present-day gas supply, and one which is certain to affect considerably their future outlook. It is not his fault if it is to this class of reader that his work must mainly appeal, for, as has been said, he is a practical man writing for practical people. Yet there is room for another study upon altogether broader lines, which would lift up from the somewhat narrow circle of the literature of gas undertakings this remarkable example of industrial chemistry practised so long and so widely, yet so severely neglected by investigators and thinkers outside the pale of the gasworks. An unlimited supply of pure gas at low prices would revolutionise the aspect of, and the conditions pertaining to, life in all our towns. But the average member of the public judges town's gas by what it has done, not by what might be expected when some part of the time and thought bestowed upon its competing service is given to gas supply, now well on the road of its second century of usefulness.

Mathematical Recreations.

New Mathematical Pastimes. By Major P. A. MacMahon. Pp. x+116. (Cambridge: At the University Press, 1921.) 12s. net.

MAJOR MACMAHON, the author of the well-known "Combinatory Analysis," presents here, as a pastime, certain problems in tesselation and designing. Everything that he writes is carefully finished, and recreations invented by him are sure to be worth attention on their merits, while in this book the numerous scraps of poetry, with which, like Sylvester in former days, he adorns his pages, add a distinctive personal touch.

The work is divided into three parts. In the first and longest of them the object is to fill, subject to certain rules, a defined area by polygons all of the same shape and size, but each coloured or numbered, like dominoes, according to a different scheme. In the second part arrangements made according to the methods expounded in the first part are "transformed" so as to give a number of pieces of the same colour but of shapes which are all different; the result is the production of a jig-saw puzzle. In the third part we deal again with pieces all of the same size and shape, and the object is to design repeating patterns which can be used to cover an area.

The first part of the book involves the consideration of how to fill in a certain way a prescribed area with wood or cardboard polygons, which may be regarded as super-dominoes. The shape of an ordinary domino is a rectangle (the breadth of which is immaterial) with two ends or faces, on which numbers or pips can be inscribed, and, if we like, each number may be taken to indicate a particular colour: by using n numbers we can get $n(n+1)/2$ different linear dominoes. If our dominoes are triangular in shape, and from some central point within the triangle we draw lines to the angular points, we get dominoes with three faces, on each of which numbers or pips can be inscribed, and as before each number may be taken to indicate a particular colour: by using n colours we can get $n(n^2+2)/3$ different triangular dominoes. Similarly, by using n colours we can get $n(n+1)(n^2-n+2)/4$ different square dominoes, $n(n^4+4)/5$ different pentagonal dominoes, and so on. With each of these sets we can make up puzzles.

A particular instance will illustrate the kind of questions treated. Consider the case of equilateral triangular dominoes. If four colours are used we get a set of twenty-four different dominoes, and these can be put together (preferably fitting in a shallow box cut to the right size) to make a regular hexagon. Naturally the point in each domino from which the lines radiate to its vertices will be taken at its centre, thus dividing each triangle into three equal compartments, and facilitating the formation of symmetrical patterns. A consideration of what conditions can be imposed for arranging the dominoes next arises. For example, we may require the arrangement to be such that the colours of adjoining faces shall be alike, as also those of all the exterior faces; the solution, subject to this condition, is, among others, given.

The patterns formed are elegant, and the puzzle of fitting the dominoes together according to some imposed condition is sure to interest a good many people, some of whom are likely to become enthusiasts in the game. In the book the colours are indicated by numerals, and thus the results appeal to the mind rather than to the eye; this is a loss.

If the dominoes are right-angled triangles, we get a hexagon arrangement of a different shape. Further, we can play with sets selected from a particular full set and arranged in suitable geometrical figures. Similar problems arise from the use of square dominoes, hexagonal dominoes, etc.

In the second part, the author concerns himself with "transformations," necessarily unlimited in number, of arrangements like those above described. This is, in effect, an exposition of a method of making jig-saw puzzles of a certain type. Probably this has never before been reduced to a system, and it may be doubted whether those who cut out such puzzles will care to proceed by rule in the matter; but, if they do, here are hints and directions for their use.

In the third part, the previous investigations are applied to the formation of "repeating patterns," built up by arranging sets of pieces which fit together. Here the author enters on a field of decorative work in which there are already excellent technical books. He says that he has developed this subject much further, and that he has in hand a work entirely devoted to it. The subject is of importance to architects and pattern-makers, and is a recognised branch of arts and crafts.

The results of the problems set out in the first part of this book are singularly effective when colours are used, and provide numerous novel and interesting recreations of a certain type. We share the author's disappointment that the cost of printing nowadays has rendered it impossible to produce the book in colour. The questions considered in the second and third parts are of a more technical character, and are likely to appeal to the specialist rather than to the general reader: to the former they will open new and interesting lines of development.

The Fishing Industry and Scientific Research.

Ocean Research and the Great Fisheries. By G. C. L. Howell. Pp. 220+20 plates+3 charts. (Oxford: At the Clarendon Press, 1921.) 18s. net.

THE reconstruction spirit of the years 1918–9 was nowhere more evident than in its relation to the fishing industry. Even before the date of the armistice the owners of trawling and drifting vessels had met repeatedly and prepared a very noteworthy memorandum, which was presented to the President of the Board of Agriculture and Fisheries later on. At that time emphasis was very

naturally placed on the importance of a highly trained fishing population in regard to questions of national defence, and the immediate object of the memorandum was to interest the Government in this and other purely economic questions. In 1919, however, a series of committees met at Fishmongers' Hall under the presidency of Sir Edward Busk, and detailed recommendations dealing with administration, publicity, education, and scientific research were prepared, printed, and circulated. A beginning was made with the work of consolidating the statutes relating to fishery. Later on the British Trawlers Federation was formed, and proposals for the creation, by Royal Charter, of a British Fisheries Society were drafted. The author of the book under notice was mainly responsible for all this organisation. Throughout the whole movement scientific research was kept in the foreground, and its absolute necessity in any possible scheme of fishery reconstruction was recognised by everyone concerned. It was understood that the industry itself was prepared to back financially a sound programme of scientific and industrial research, and, without doubt, such programmes of education and research would now have been in practice but for the wholly unexpected partial collapse of the fishing industry that occurred in 1920.

These remarks will make clear what is the attitude taken up by Mr. Howell in writing his book. It is an account of the life-histories and economic significance of the various species of marine fishes, and it is very well done indeed. Apart from a few errors, inevitable, perhaps, in a work of this kind, it is a trustworthy account of the material of the marine fisheries, written in a plain but very attractive manner, fortified with clearly constructed statistical statements, very well illustrated and beautifully printed. But, much more than all that, it is a plea, on almost every page, for the further prosecution of marine research in relation to the fisheries, and it aims at the communication of the results of such work to the fisherman and owner of fishing vessels. It is a useful protest against the pedantry of the fisheries investigator. Little of what has been discovered has ever been presented in such a manner as to be understood by the industry in general—though this is quite practicable, as the book itself proves. Men of science almost always write for other men of science, though sooner or later their results must receive application, and this application would come all the more quickly if there were a true *liaison* between the administrators, the scientific workers, and the industry. The furtherance of such a working agreement is, all the way through, the main object of Mr. Howell's admirable book.

J. J.

Wegener's Displacement Theory.

Die Enstehung der Kontinente und Ozeane. Von Prof. Dr. Alfred Wegener. *Die Wissenschaft: Sammlung von Einzeldarstellungen aus den Gebieten der Naturwissenschaft und der Technik.* Herausgegeben von Prof. Dr. Eilhard Wiedemann. Band 66. Zweite gänzlich umgearbeitete Auflage. Pp. viii + 135. (Braunschweig: Friedr. Vieweg und Sohn, 1920.) 30 marks.

THIS book makes an immediate appeal to physicists, but is meeting with strong opposition from a good many geologists. This opposition is to be expected, for the author replaces the whole theory of sunken continents, land bridges, and great changes of earth temperature by a displacement theory.

Prof. Wegener's thesis is that the continents are of lighter material, and float like icebergs on a heavier plastic which reaches its highest level at the bottom of the oceans; the poles are not fixed relative to the plastic, and have occupied widely different positions, as, for instance, when Central Europe was a Sahara, or, again, when the great coal fields were laid down along a great circle (equator); land masses under gravitational influence move away from the poles and westwards.

Thus the Americas in their westward drift have heaped up the Andes and the Rockies. The South Atlantic opened early, but the northern portion did not exist until much more recent times. At the great Ice age, in fact, the glaciation in both hemispheres was due to an ordinary polar ice cap. India once stretched down over the Indian Ocean, being united to Africa and Australia. Since that time the Himalayas have been piled up, and Australia has left New Zealand far behind.

Actual measurements of continental and sea levels establish the fact that instead of there being a random distribution about one level there are two well-marked averages, a fact difficult to explain on any subsidence theory. Again, it was shown by Wilde that the earth's magnetic field can be closely imitated on a globe where iron sheets are placed over the ocean areas. On the present theory this is due to the plastic interior being richer in iron and rising higher under the oceans, where there is thus a thicker layer below the temperature at which iron loses its magnetic properties. Recent astronomical work has shown that the latitude of North American and European stations is increasing, but in the absence of measurements from the Far East we cannot prove that this is not due to a displacement of the pole.

The book brings forward a mass of geological

corroboration, although the author only claims to have "got it up" since the idea came to him. The revolution in thought, if the theory is substantiated, may be expected to resemble the change in astronomical ideas at the time of Copernicus. It is to be hoped that an English edition will soon appear.

The Earliest Forms of Society.

(1) *Primitive Society: The Beginnings of the Family and the Reckoning of Descent.* By Dr. E. S. Hartland. Pp. v+180. (London: Methuen and Co., Ltd., 1921.) 6*s.* net.

(2) *Primitive Society.* By Dr. R. H. Lowie. Pp. viii+453. (London: George Routledge and Sons, Ltd., 1921.) 21*s.* net.

IT is interesting to place these two books side by side in order to contrast the methods of attacking the problems involved in the study of primitive society which have been adopted by the respective schools to which the authors belong. (1) Dr. Hartland is one of the leading exponents of the view that there is a reasonable presumption that in the evolution of society wherever the patriarchal system now exists it has been preceded by the matriarchate. In the volume under notice he restates this view and summarises the evidence on which it is based in popular form. (2) Dr. Lowie, however, maintains that this theory is based upon an *a priori* assumption, and that Morgan and his followers, in their desire to formulate a logical scheme of social evolution, have distorted the facts by confining their attention to a single group of data. Pouring scorn on the heads of "the older school of anthropologists," he insists upon the empirical character of the evidence, and would have each case taken on its merits, subjected to intensive study, and treated as a whole.

After a review of the evidence on these lines, Dr. Lowie concludes that the theory of unilinear development is entirely fallacious and unwarranted. So far from the group organisation of the *sib* or clan being the foundation of primitive society, it is only one, and that frequently not the most important, of a number of forms of organisation to which the individual may belong. While he is prepared to allow that duplication of conditions may produce duplication of a sequence, as in the relation of polyandry and female infanticide, he formally abjures independent reproduction of the same series of "stages." He goes so far as to say that he is "not convinced of the reality of the totemic phenomenon," and for him the problem of totemism resolves itself into a "series of specific problems not related to one another." If, however, he believes in independent development only in the very limited degree indicated, neither is he a whole-hearted supporter of diffusion; while attaching full weight to diffusion, particularly in continuous areas, he recognises that it does not necessarily preclude independent invention within a limited scope.

It must be acknowledged that if Dr. Lowie's argument in favour of empiricism fails to carry conviction, he has done good service in emphasising the necessity for intensive study of all the facts of a given area as a whole. By concentration on the group organisation of the kin, the supporters of the evolutionary theory have sometimes been led astray. The existence of the family as a social unit at an early stage has been obscured by the view that the family emerged from the group. Dr. Hartland, indeed, speaks of "sexual promiscuity—relieved perhaps by temporary unions in the nature of monogamy." At the same time, owing to his preoccupation with kin organisation, he is unable "to bring Andamanese society within any category at present known." This fact does not, however, suggest to Dr. Hartland a modification of his conclusions, as might perhaps be expected; he prefers to await further evidence.

Our Bookshelf.

The Calendar: Its History, Structure, and Improvement. By Alexander Philip. Pp. xii+104. (Cambridge: At the University Press, 1921.) 7*s.* 6*d.* net.

THIS is not the kind of work that we expect from the Cambridge University Press. It contains numerous historical errors, and is not free from astronomical errors also. The author has endeavoured to guard against criticism of the latter by stating in his preface that his astronomical facts have been derived from the commonly available sources, and that he has disregarded "qualifying refinements known to modern astronomy but irrelevant to a calendrial purpose." This ambition has not prevented him, however, from stating the length of the tropical year to hundredths of a second, or the length of 4000 tropical years to an exact number of minutes. The introduction of these refinements, "irrelevant to a calendrial purpose," might have been pardoned, if they were accurate, which, unfortunately, they are not. But it is in the history of the calendar that the defects of the book are particularly displayed. The author ignores the two most valuable treatises on the subject, Ideler's "Handbuch der Mathematischen und Technischen Chronologie," and Ginzel's work which bears the same title. He writes in an easy way of Egyptian, Chaldean, and Chinese calendars;

but his knowledge of things "Chaldean" may be gauged by a footnote on p. 4, part of which is repeated in a footnote on p. 48. We quote the fuller note: "The 365-day year appeared at Babylon from Egypt after the overthrow of the Assyrian Empire by Nabonassar; but Chaldea subsequently developed a luni-solar, Egypt a solar, calendar." Comment is superfluous.

Bartholomew's General Map of Europe, showing Boundaries of States according to Treaties, 1921. Size 35 in. × 23 in. (Edinburgh: J. Bartholomew and Son, Ltd., 1921.) 1*s*. net.

THIS map of Europe, on a scale of 1 to 5,500,000, is designed to show the political boundaries and the chief lines of communication by land and sea. It makes no attempt to show the surface features of the land, and in that respect is open to criticism, although the adequate depiction of relief would certainly necessitate a reduction in the number of names. As regards boundaries, railway lines, and place-names, the map is full and accurate. We note, however, that the small States San Marino and Liechtenstein are shown by distinct colours, but are not named, while the principality of Monaco is named, but not indicated as an independent State. The map extends no farther north than about lat. 60° N., with the result that the new Finno-Russian boundary with the Finnish outlet to the Barents Sea cannot be shown. On the east its limits exclude the greater part of the Caucasus and the new States in that region. There is a small inset map showing the boundaries in 1914. The excellence of the colour printing and the legibility of the names make this a useful map for general reference purposes.

Oil Firing for Kitchen Ranges and Steam Boilers. By E. C. Bowden-Smith. Pp. ix + 102. (London: Constable and Co., Ltd., 1920.) 9*s*. net.

THE bulk of this book is taken up with descriptions of the Scarab burner and its application during the war to kitchen ranges in Egypt. The relative prices of coal and oil fuel in Egypt make it a big advantage to employ the latter, and the Scarab burner appears to have been of great service on account of its simplicity of construction. In the hands of quite unskilled persons kitchen ranges fitted with this burner have given very little trouble, and show a large saving in the cost of fuel. Thus the Turf Club at Cairo spent £E13·75 per week on coal and wood, and after conversion to oil fuel the weekly expenditure amounts to £E5·92. The drawing and descriptions of the burner and of the methods of fitting it to ranges will be readily followed even by non-technical readers. Some chapters are included on oil-firing steam boilers. It may be well to mention that a supply of compressed air is required; this presented no difficulty in Cairo, since there is a public service of compressed air in connection with the main drainage system, and air was taken from the mains.

The Chemistry of Colloids and Some Technical Applications. By Dr. W. W. Taylor. Second edition. Pp. viii + 332. (London: Edward Arnold and Co., 1921.) 10*s*. 6*d*. net.

THE second edition of this work, like the first, is well adapted to introduce the general student to the subject, the theoretical portions and the accounts of experimental procedure being well balanced. The amount of revision, however, appears, on examination, to be rather less than the author's remarks in the preface lead one to expect. Thus the "Valency Rule" still appears in its old and, as recent shattering criticism has shown, very spurious simplicity. Although earlier "complex" theories are given, Pauli's later and more thorough work is not mentioned. Recent results on protection and anomalous adsorption might also have found a place. With a subject in constant flux it is of course difficult to draw the line, but the author appears to have done so distinctly on the side of caution. In spite of these defects the book is still one of the most useful general text-books of colloid chemistry available in English.

The Fireman's Handbook and Guide to Fuel Economy. By C. F. Wade. Pp. viii + 84. (London: Longmans, Green, and Co., 1920.) 2*s*. 6*d*. net.

A GOOD deal of information which will be of service to firemen in helping them to understand what goes on in furnaces and boilers will be found in this little book. The author, however, is not quite happy in some of his fundamental explanations. Thus on p. 3 we read that "heat is a form of energy that can be measured as to quantity by means of a thermometer." Again, on p. 7 appear the following curious statements: "The only heat of the steam that does useful work is the amount added to the water to bring it just to boiling point." "It is much more economical to work at the highest possible pressure so that the latent heat may be low and the useful heat as high as possible." The sketches given in the book are clear, and will be understood readily by stokers.

A First German Course for Science Students. Second edition, revised. By Prof. H. G. Fiedler and Prof. F. E. Sandbach. Pp. x + 99. (London: Humphrey Milford: Oxford University Press, 1920.) 4*s*. 6*d*. net.

To many students of science an introductory course in German constructed to meet their special needs will be very welcome. The first portion of the work under notice consists of a number of passages descriptive of chemical and physical phenomena and experiments by means of which German technical phrases and words are introduced to the reader. Each passage is based on numbered paragraphs appearing in the outline of German grammar which constitutes the latter portion of the book. Here the examples given are, so far as possible, of a scientific nature. A useful vocabulary completes the book.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Test-plates for Microscopes and Microscopic Definition.

IN NATURE of September 1 last (vol. 108, p. 10) I suggested that dry films of some of the aniline colours might prove suitable surfaces on which to rule the very fine lines required for test-plates. Since that time I have made some trials with films, using various dyes and various materials for the ruling-point. The dyes were eosin, saffranin, cyanine, methyl-green, methyl-blue, and methyl-violet. The last of these gave the most uniform films, leaving, on the evaporation of the solvent, a bright surface free from structure. Cyanine gave good films, though not quite so opaque as the methyl-violet for the same thickness. The others, either from a tendency to crystallise or from drying with a dull surface, were not so satisfactory.

The points for ruling were of steel, garnet, carborundum, and diamond. In all cases, except that of steel, the natural points found among broken fragments were chosen, and I doubt whether, without a somewhat elaborate grinding tool, an artificial point could be made so sharp as that given by the natural breakage.

The points have to be selected by trial, as the microscope is of little assistance in determining their real terminal shape. The only apparatus which was at hand for ruling purposes was a Cambridge rocking microtome, and the minimum interval between the lines (which corresponds, of course, with the thinnest section it could cut) was somewhat greater than 1/60,000 of an inch. No great accuracy in the spacing of the lines could be expected, but it is to the credit of the design of this microtome that there was no difficulty in getting well-separated lines at 30,000 per inch, and occasionally the 60,000 lines were quite apparent.

The uncertainty with these close lines was due, I think, chiefly to the rather rough workmanship of the bearings of the rocking arms, but in part, perhaps, to those of the point-holder.

The only real difficulty in close ruling is that of finding a fine enough point and applying it to the surface with a small enough force.

As mentioned in my previous communication, this force must not exceed a small fraction of a grain, and should remove the film but not scratch the glass. In the trials the point-holder was made as shown in Fig. 1, the materials being reed and split-cane put together with silk splicing and shellac cement.

This light and rigid frame could rock on the needle-points, one of which entered a conical pit, and the other a **V**-shaped groove in a fixed fitting which replaced the knife of the microtome. The whole forms a pendulum the effective weight of which (a few grains) is, say, w, of length L, which if displaced by an amount a exerts a force wa/L in the direction opposite to the displacement. Thus by placing the plate to be ruled at a suitable distance from the undisturbed position of the ruling-point the force can be adjusted as required.

While the film is being advanced for a fresh line the ruling-point is withdrawn by means of a silk fibre leading from the swinging frame to a bell-crank mounted on the fixed support.

A few photographs of bands ruled with this apparatus are given in Fig. 2. All these were made with diamond points. With a newly ground hardened steel point the 30,000 band was well shown, but the tool soon became too blunt for any spacing less than 15,000 per in. Garnet and carborundum points lasted fairly well for 30,000 per inch lines, but, as might be expected, were inferior to diamond so far as wear was concerned.

In the earlier trials from ten to sixty lines were ruled for each band, but later it was found that four or five lines were quite sufficient to show all the effects which various kinds of stage illumination have on the definition.

It is only with opaque and very thin objects that

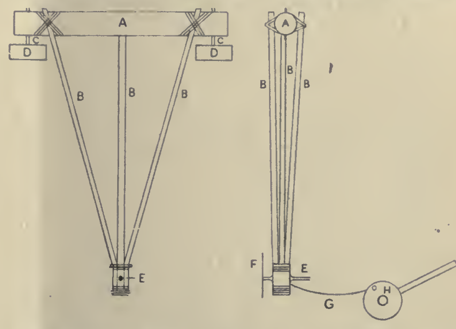

FIG. 1.—Holder for ruling point. A, Reed; BBB, split cane; CC, needle points; D, fixed support; E, diamond point; F, aniline film; G, silk fibre; H, bell-crank.

these can be examined to any advantage, thinness in this case being in comparison with the wave-length of light.

The methyl-violet films from which the photographs were taken were less than one-tenth of a wave-length in thickness, and, though not quite opaque, transmitted only a deep blue with some little red. The measurements of thickness were made by noting the displacements of the Newton's rings formed between a lens and the film at a place where part of the latter had been removed.

Test objects, such as diatoms, are much thicker than this, and, with them, what is seen in the field

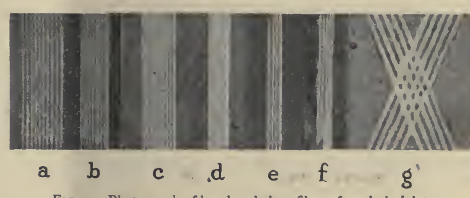

FIG. 2.—Photograph of bands ruled on films of methyl-violet.

a, 10 lines about 15,000 per in. ×350		*e*, 4 lines about 37,000 per in. ×600	
b, ,, ,, 20,000 ,, ,,		*f*, 5 ,, ,, 35,000 ,, ,,	
c, ,, ,, 17,500 ,, ,,		*g*, Intersection	
d, ,, ,, 25,000 ,, ,,		of bands 17,500 ,, ,,	

The photographic lines are not nearly so well defined as they appear when examined by the eye.

is merely a phenomenon in which the thickness and wave-length are both concerned.

I think that the late Lord Rayleigh was the first to emphasise the fact that optical definition in general depends on the difference of the optical length of the paths of the rays the convergence of which forms the images of contiguous objects. Let A_1, A_2 (Fig. 3) be two objects in a line making an angle β with the focal plane of the lens, B_1, B_2 their images, and f_1, f_2 the conjugate focal lengths.

The difference of length of the paths A_1, B_1, A_2, B_2 of rays making an angle i with the principal axis is $\alpha \sin (i+\beta)$, and unless the average of this for all values of i exceeds $\lambda/4$, the images B_1, B_2 will appear connected, and will not be clearly separated until the average is about $\lambda/2$. From this it may be seen that not only is it impossible to separate the images of objects in the focal plane which are much closer together than $\lambda/2$, but also that the same limit defines the distance out of focus at which objects may be placed without altering the character of their images. This is a point which is well brought out by the lines on the aniline films.

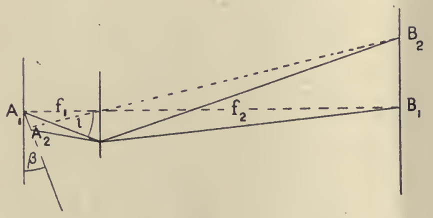

FIG. 3.

It may be asked what is the greatest magnifying power which can be usefully given to microscopes? Since objects closer together than $\lambda/2$ cannot form separate images, the greatest useful magnification is that which makes $\lambda/2$ visible to the eye.

A very good eye can just distinguish minutes of arc, or say objects separated by 1/350 in. at the distance of the eye from the stage. Then, taking the half-wave-length as the 1/100,000 of an inch, all details would be visible with a magnification of 100,000/350, or a little more than 280. Not all eyes, however, are capable of distinguishing minutes, and for convenience of observation, magnifications of twice this amount or more are used in practice, but the extra power reveals no new detail.

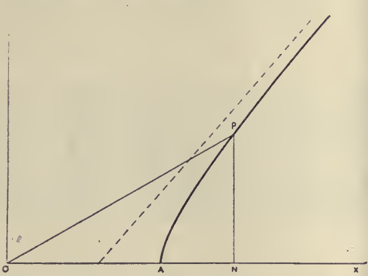

FIG. 4.—Form of plano-convex lens for the conversion of divergent rays into a parallel beam. O, Radiant point; OX, principal axis; PA, section of lens surface.

An idealised lens is merely a means of changing the radius of curvature of a wave-surface from f_1 to f_2 while preserving the constancy of the optical length of all the rays from focus to focus.

From these conditions the form of the lens which will achieve the result may be deduced. As a simple example, find the form of a plano-convex lens which will convert spherical waves originating at O (Fig. 4) into a parallel beam.

Let the convex surface of the lens cut the principal axis OX at A, and let the refractive index of the material be μ. The form of the surface is determined by the relation $OA+\mu AN=OP$. Elementary algebra shows that the curve PA is a hyperbola the asymptotes of which make an angle $\tan^{-1}\sqrt{\mu^2-1}$ with the axis of the lens. The complexity of actual objectives arises from the necessity of effecting the change of radius of curvature by means of spherical surfaces.

A. MALLOCK.

9 Baring Crescent, Exeter.

The Antitrades.

I AM glad to support the appeal for observations of the motion of cirrus-clouds in the inter-tropical region and elsewhere made by Prof. van Bemmelen in his letter on the Antitrades (NATURE, February 9, p. 172). It is very interesting that the results which he has obtained by direct observation, with only such additional information from dynamics as may be got from a consideration of the general character of the Australian pressure, should coincide so excellently with results which we obtained here from the calculation of the distribution of pressure at various levels, and the assumption that the wind flows along the isobars.

There are some details in Prof. van Bemmelen's maps which indicate a flow of air *across the equator* which I should be disposed to modify in view of the peculiar conditions under which such a transference of air must take place. I hope to give the details of the information that we have compiled about this subject at some future time, and confine myself for the present to saying that the atmosphere seems to be able to use the circulation of air round a strip of doldrum region as a means of providing for currents which flow westward on the south side, and eastward on the north side, of the equator in a general slope of pressure from south to north across the equator. Thus the doldrum region becomes a sort of elongated clockwise "centre" for the winds of the monsoon north and south of the equator.

I would add also to Prof. van Bemmelen's appeal for observations of cirrus a plea for the extension of observations with pilot balloons. Methods are now so well understood that the authorities could easily provide a *technique* which could be followed by those accustomed to surveying and others, and would provide invaluable information The committee of the British Association which concerns itself about the upper air has already taken up the question, and if anyone who is in a position to help in this matter would communicate with me or with the secretary of the committee, Capt. C. J. P. Cave, of Stoner Hill, Petersfield, we shall be greatly obliged.

NAPIER SHAW.

School of Meteorology, Royal College of Science, South Kensington, S.W.7, January 12.

The Isotopes of Mercury.

IT appeared to be so definitely one of the fundamental assumptions of physics that pure mercury has a constant density under given physical conditions that when Brönsted and Hevesy announced that they had separated it into fractions of different density (see NATURE, September 30, 1920, p. 144) it appeared desirable that the separation should be confirmed by other observers. One of us finds that when mercury (purified chemically and by distillation in a vacuum) is distilled in a very high vacuum the first sixth of the original mercury condensed is of lower density than the last sixth. The difference in density found for these fractions was 44 parts in 1,000,000. This

difference does not appear to be due to error in the density determinations for the mass found in different experiments, for a constant volume of the same specimen of mercury is constant to one part in a million, and with special care it is constant to a few parts in ten millions.

These experiments indicated, too, that any process of distillation would give some separation of the isotopes of mercury, and the question naturally arose: Upon what evidence has the density of mercury been regarded as constant? The matter had been investigated at the International Bureau of Weights and Measures by M. Marek in 1883, and he writes of the results which he obtained: "It is noticed in comparing these figures that the density of mercury varies slightly from one sample to another according to the method of purification. This result has already been obtained by Dr. H. Wild in a study of this subject specially undertaken." The results which Dr. Wild published in 1874 are not available to us. M. Marek, however, quotes results communicated to him by Dr. Wild, which, although ambiguously stated, make it appear as not improbable that Dr. Wild more than forty years ago separated mercury into specimens of different density.

T. H. Laby.
W. Mepham.

Natural Philosophy Department, University of Melbourne, December 30.

Where did Terrestrial Life Begin?

The question raised by Dr. Macfie in his letter in Nature of January 26 concerning the place of origin of life on the earth is not one which directly concerns the meteorologist, but Prof. J. W. Gregory's comments upon it seem to call for discussion from the meteorological point of view. Dr. Macfie suggests that in the gradual cooling of the earth mountain-tops would first reach a temperature to make them habitable for human life, while the sea would for further centuries remain above the critical temperature. Prof. Gregory feels hesitation in accepting the conclusion reached that life would first be found on the mountains, considering that while "the mountain summits would have stood like islands above a sea of hot mist . . . any wind would have at times submerged the mountain summits beneath the lower atmosphere, and they would have been subject to violent fluctuations in temperature and moisture which would have been unfavourable to primitive life."

Now with an atmosphere of homogeneous composition it is impossible to warm a mountain summit by immersing it in warm air drawn from the lower layers; if the conditions are initially stable, adiabatic cooling sees to it that the warm bath of air becomes a cold one before the summit is reached. We must therefore assume that in these early days the earth's atmosphere was not homogeneous, but that hot layers of dense gas occupied the lower levels, while lighter constituents of low temperature floated above. In these circumstances a stirring up of the lower layers might raise the temperature at higher levels temporarily, but is there any evidence that such a condition existed? No trace of separation and stratification of the different gases under gravity is found in the troposphere at the present time, atmospheric turbulence being sufficient to maintain a similar constitution at all heights. If the gases were stratified in the manner suggested it would afford proof that vertical turbulence did not occur, and thus the very existence of stratification would show that the layers below never rose to the mountain-tops

Meteorological evidence does not seem to support Prof. Gregory's conclusion that the mountain-tops would be subject to such violent fluctuations of temperature as would render life impossible.

J. S. Dines.

66 Sydney Street, S.W.3, February 6.

Dr. Macfie's letter (Nature, January 26, p. 107) accepts the common idea that the surface of the earth was formerly very hot—an assumption which is probably not well founded. If the earth was formed by accumulation of meteoric matter, it began its existence as a cold body the interior of which afterwards became heated by condensation, aided by atomic disintegration, while its surface was kept at a moderate temperature by radiation. It is difficult to believe that a globe so small, comparatively, as the earth could produce enough heat to raise its surface temperature anywhere near to the melting point; all igneous rocks are probably formed at some distance beneath the surface.

I imagine the first beginnings of life to have occurred at a very early epoch in the earth's evolution, namely, as soon as (1) the surface became warm enough and (2) elements capable of forming labile energy-storing compounds were present. It is not certain that solar radiation was necessary at first; the kinetic energy (heat and electricity) may have been derived from the earth itself.

Life at this stage would be of the humblest kind; we should scarcely recognise it as life nowadays. There would be no definite organisms, only diffuse substances trading in energy. Between this stage and the development of *cellular* organisms an immense period may have elapsed, and that period may have witnessed many intermediate stages. The achievement of the cell-form in living organisms must have marked a most important epoch in the history of life.

Chlorophyll may have been evolved at quite a late stage, as the culmination of a series of attempts at the formation of energy-fixing pigmentary bodies, most of which probably had iron as an essential ingredient.

The high stage of development shown in the earliest known fossils suggests that the geological period occupied by their evolution was vastly greater than the period since. The dawn of life may have occurred before there were either mountains or seas; all evidence of such early life has been obliterated by the metamorphosis and fusion of the deeper rocks.

Further discussion on this subject may be found in a paper by the present writer in the Proceedings of the Birmingham Natural History and Philosophical Society, vol. 11, pt. 1.

F. J. Allen.

8 Halifax Road, Cambridge, January 28.

Rainfall and Drainage in 1921.

I have read with interest the letter of Mr. W. D. Christmas in Nature of January 26 concerning the rainfall and drainage at Rothamsted during the very dry year 1921.

A few years ago three rain-gauges were installed at Craibstone, the experimental farm of the North of Scotland College of Agriculture. Like the Rothamsted gauges, each of these is one-thousandth of an acre in area, and contains a block of soil which has been enclosed in its natural condition without disturbance. The soil at Craibstone differs greatly from the heavy loam of Rothamsted, and is composed of sharp granitic drift which is easily pervious to

water. Each of the gauges is 40 in. in depth. The rainfall alongside them is measured by an ordinary 5-in. Snowdon rain-gauge. The total rainfall recorded for the year 1921 was 17·86 in. In 1920 it was 32·25 in.; the average is probably about 30 in., but we have not yet obtained a record over a sufficiently long period to establish a trustworthy average. No. 1 drain-gauge is unmanured, and the figures quoted below refer to it. The drainage for the year from this gauge was 4·93 in. No drainage at all came through from early June to nearly the end of October, and during seven months, from the middle of May to the middle of December, the total drainage was 0·046 in., or less than one-twentieth of an inch. On the other hand, in 1920, when the rainfall was 32·25 in., the drainage was 18·09 in., and there were only two months, July and August, when there was no drainage.

In many parts of this district springs failed which were never known to have failed before, and there was great difficulty in many places in obtaining a sufficient water-supply. The reason for this is apparent when we find that from the middle of May until the end of the year practically no water passed through the subsoil.

Although the total rainfall for the year was so low, it was well distributed throughout the year and rain fell in every month. Quite a good crop was grown upon Craibstone Farm. The drain-gauges themselves as well as the surrounding field were under turnips, and both yielded a good crop.

The year 1922 so far as it has gone provides a great contrast to 1921. During the month of January more drainage came through No. 1 gauge than during the whole of the previous year. The rainfall recorded was 5·61 in., while the drainage from No. 1 gauge was 5·69 in. There were only two days during the whole month on which rain or snow was not recorded. The underground water-supplies are now being well replenished, and, although all the springs have not yet responded, there is no doubt that after the rainy month of January they should soon begin to recover.

James Hendrick.

Agricultural Department, Marischal College,
Aberdeen, February 3.

Scientific Literature for Russia.

At the beginning of last year a British committee was formed with the object of sending books and other publications to men of letters and science remaining in Russia.

The committee was assured that any such works, if addressed to the House of Science or the House of Literature and Art in Petrograd, would reach their destination and would be much appreciated by literary and scientific men meeting there who were cut off from the intellectual life of the rest of the world.

An appeal was therefore made for funds to purchase works of a non-political type for dispatch to Petrograd, and Prof. Oldenburg, permanent secretary of the Academy of Sciences, furnished a list of books and other publications much needed by Russian *savants*. The books particularly desired were those which included accounts of current problems and developments of pure and applied science.

As the result of this appeal the sum of 448*l*. 17*s*. 5*d*. was subscribed, and several scientific societies, including the Royal Society, entrusted the committee with their publications for transmission to Petrograd. The Russian Trade Delegation undertook the dispatch of the books, and ten cases have been forwarded.

Prof. Oldenburg, writing on December 21 last, expressed the deepest gratitude of scientific workers in Petrograd for this stimulating intellectual aid, and says that they have been placed in a special reading-room at the House of Savants, where they are consulted by a large number of students throughout the day, and have been the means of reviving scientific interests and work. He sends the most cordial thanks of men of science in the city to all who have contributed towards the stimulus to scientific investigation which the new publications have given them.

Having thus established contact with scientific men in Russia and enlightened them as to the progress of research from which they have been separated by political circumstances beyond their control, the committee is of the opinion that its task has been accomplished. Of the fund remaining in its hands the sum of 50*l*. has been expended upon books desired by the University of Latvia, and a small balance will be handed over to the Universities Committee of the Imperial War Relief Fund.

The committee gratefully acknowledges the generosity of the response to its appeal, and believes that the intellectual relief thus afforded will do much to strengthen Russian scientific life.

A statement of accounts, audited by Messrs. W. A. Browne and Co., chartered accountants, will be sent to anyone who desires a copy.

R. A. Gregory,
Chairman.
C. Hagberg Wright,
Hon. Secretary and Treasurer.
British Science Guild Offices, 6 John Street,
Adelphi, London, W.C.2, February 11.

Cyclic Conditions and Rejuvenation in Hydroids.

Several colonies of *Tubularia indivisa* which have lived in the aquaria for three years are noticed as exhibiting alternating periods of activity and rest. Broadly speaking, the hydranths die off about midsummer and reappear about midwinter, the times in one particular case for the growth of new lengths of hydrocaulus and for the formation of new hydranths being December, 1919, January, 1921, and January, 1922, and in another January, 1920, January, 1921, and December, 1921, the hydranths in each case finally dying off in the intervening periods between the end of May and July. Colonies obtained from moderate depths in January generally show clearly marked new ends to their hydrocauli, such new growth often being an inch or more in length.

At the same season died down colonies of Stauridium and Melicertidium in the aquaria, and Clava, Syncoryne, Campanularia, Antennularia, Plumularia, Halecium, etc., in the sea are found showing signs of rejuvenation.

In a paper on "The Effect of Hydrogen-ion Concentration and Oxygen Content of the Water on Regeneration and Metabolism in Tadpoles" (*Journ. Exper. Zool.*, 1920), M. E. Jewell shows that rate and amount of regeneration increase with increase of oxygen content of the water, but decrease with decrease in temperature, and that the optimal P_H for regeneration is at or near neutrality. In connection with these experimental results it is interesting to note that the above regenerations begin when the sea temperature is approaching its minimum, at which time the oxygen content is greatest, and continue with increasing rapidity during spring, when increasing alkalinity further stimulates growth and an ever-increasing food supply is available.

In view of our incomplete knowledge of the interrelations of physical factors in the sea it is extremely

hazardous to make binding statements, but it seems probable that increase of light stimulating photosynthesis will tend to set back the incidence of maximum oxygen content, especially in a partly closed area like the Clyde Sea area, so that it does not actually coincide with minimum temperature, in which case it would appear that light and high oxygen content are the primary factors influencing these rejuvenations. RICHARD ELMHIRST.

Marine Biological Station, Millport.

Tin Plague and Arctic Relics.

IN view of the apparent public interest in my letter in NATURE of January 19, possibly a further note on the subject may be permitted. One letter I have received was from a Government Department concerned with food supplies for the Navy, and I was asked a number of questions. The first one (to my surprise) was "The name of the firm who produced the article referred to." That had never occurred to me! However, in an endeavour—which proved successful—to reply to that query, I found a note which seems worthy of reproduction here.

In an "Appendix to the Narrative of a Second Voyage in Search of a North-West Passage and of a Residence in the Arctic Regions during the Years 1829, 1830, 1831, 1832, 1833, by Sir John Ross," pp. cxi–cxiv, is "an analysis of fluids, etc.," from which the following extract is made, in addition to which is a report on brine, wine, rum, lemon-juice, and mustard, from Fury Beach :—

"I am indebted for the following article to my friend, Mr. Thomas Rymer Jones, who, in conjunction with Mr. Hemmings, submitted the articles I gave them to a careful examination, and made the following report, which requires no comment, as the acquirements of these gentlemen are known to qualify them highly for such an investigation :—The provisions, of which the following account is given, had been lying exposed to the climate for eight years, in the latitude of seventy-three degrees and forty-seven minutes north, and longitude of ninety-one degrees and forty-seven minutes west, and very little above high-water mark. The preserved meats, with few exceptions, were the manufacture of Messrs. Gamble and Co., and being enclosed in tin cases, could not be discovered by animals who depend on the sense of smelling; these were cylinders of various sizes, the ends of each becoming concave or convex, according to the degrees of contraction or expansion caused by the climate, secured them against bursting from its effects, and the contents were found to be in nearly the original state: these consisted of beef, roasted and boiled; veal, mutton, spiced meat of various kinds, turnips, parsnips, and carrots, all of which were found to be in excellent preservation. The soups, which were preserved in quantities from a quart to a gallon, were excellent, and we left a considerable quantity behind, but no meat of any kind. The flour, which was preserved in iron-bound casks, and had been likewise exposed for eight years to the climate, was found to be in good condition; for although in many cases the hoops had slackened, so as to admit moisture into the cask, it penetrated but a short way, while the whole of the interior was perfectly sound. The bread, of which there were many casks, was in a good or bad state, according to the soundness of the cask which contained it, and we employed ourselves in separating the bad from the good and put all into repaired casks. A part of this, and also of the flour, is sufficient with the addition of the remaining soup to sustain the life of twelve men for a year. Owing to the pickles being also in cask they had suffered much, the vinegar having leaked out of most of them: fifty of these, and twenty-five of lemon-juice, are also left, at a little distance south of the house, and covered with coals, as the most effectual way of preserving both."

T. SHEPPARD.

The Museums, Hull.

A New Series of Spectrum Lines.

WITH a long hydrogen tube, viewed end on, as a source, lines have been observed at $4{\cdot}0^5\mu$ and $2{\cdot}6^3\mu$, which, according to Bohr's theory, may be explained as due to an electron falling from the fifth to the fourth and from the sixth to the fourth rings respectively, forming the first two members of a new series.

Lines have been observed at wave-lengths $1{\cdot}8^8\mu$, $1{\cdot}2^8\mu$, $1{\cdot}0^9\mu$, $1{\cdot}0^1\mu$, and $0{\cdot}9^5\mu$. These form the first five members of the Paschen series due to an electron falling into the third ring from the fourth, fifth, sixth, seventh, and eighth rings respectively. The first two of these were observed and accurately measured by Paschen.

The first line of the new series is approximately one-fourth the intensity of H_α; the first Paschen line, more intense than H_α in the ratio 4 : 3.

F. S. BRACKETT.

Johns Hopkins University, January 24.

Araucaria imbricata.

REFERRING to the note in NATURE of January 19, p. 87, about this archaic tree ripening seed, may I say that it will do so regularly in this country if it gets a chance? But whereas it is diœcious, seed is produced only where male and female trees are planted near enough to each other for the wind to carry the pollen from the male catkins to the female cones. In 1906 I took Dr. Augustine Henry over to Castle Kennedy. There had been a heavy gale a few days before, and the ground about the fine avenue of Araucaria was thickly strewn with ripe seed, whereof we collected a bagful. Some we ate, treated like chestnuts, and found them excellent. Others I caused to be sown, and have now a hilltop planted with more than twelve hundred monkey-puzzles, some of which are 12 ft. high. The female tree produces seed only in alternate years as the cones take two seasons to ripen. HERBERT MAXWELL.

Monreith, Whauphill, Wigtownshire, N.B.

Some Problems of Long-distance Radio-telegraphy.

IN the portion of the abridgment of my Trueman Wood lecture on the above subject published in NATURE of February 2, p. 140, I quoted an instance taken from a paper by Dr. Van der Pol of the ratio between the observed receiving aerial current and that calculated by the diffraction formula for the case of the Nauen–Darien transmission. It appears, however, that a numerical error was made in Dr. Van der Pol's original calculation, which, however, he corrected in the *Phil. Mag.* for July, 1920. This correction, unfortunately, I overlooked. It appears that the correctly calculated value of the received current is not $0{\cdot}6 \times 10^{-13}$ amp., but $1{\cdot}9 \times 10^{-10}$. Hence the actual current is only seven thousand times that predicted by the diffraction formula, and not two million times. This discrepancy does not, however, invalidate the conclusion that wave-diffraction alone cannot account for long-distance wireless telegraphy. J. A. FLEMING.

London, February 14.

Flowering Dates of Trees along Main British Railway Routes.

By J. Edmund Clark.

A FEW months ago the Editor of NATURE sent me, as joint editor of the Phenological Reports published by the Royal Meteorological Society, an interesting problem. He said:—"It has been pointed out on several occasions that in travelling from the West of England (Devon and Cornwall) to London, fruit trees are usually seen to be much more forward as regards flowering nearer London than in the West." I was therefore asked whether I had, among the "phenological observations, records of such flowering dates arranged according to longitude so as to determine whether fruit trees do, normally, bloom earlier near London than far away, and whether this is true also in passing from London to the East."

Our thirty years' records give no basis for a direct reply, since of set purpose garden flowers and fruits were excluded by the late Edward Mawley from the thirteen selected blossomings. These begin with the hazel (mean for the British Isles, February 13) and close with the ivy (October 2). The many varieties of most of our fruit trees is the obvious ground for their exclusion.

It seemed, however, worth attacking the problem indirectly, even though at first the supposed earliness appeared to be improbable. The four fruit-time plants in our list, blackthorn, garlick hedge-mustard, horse chestnut, and hawthorn, average two and a half days earlier in England, S.W., than in England, S.E. and E., in our thirty years' means.

The basis for investigation required:—

(1) Sufficient stations. For the first time in the thirty years 1920 supplies these, thirty-five being available.[1]

(2) The blackthorn gives us the opening, the other two trees the closing, stages of fruit flowering.

(3) Unfortunately 1920 was abnormally early, and therefore prolonged. This is shown by the following table, giving the days early compared with the mean:—

1920		S.W.	S.E.	E.
Blackthorn, early	days	30	24	20
Chestnut and may, early ..	,,	10½	18	12
Prolongation, fruit flowering ..	,,	19½	6	8

The possible results on relative conditions may well be serious, especially as to insolation. Obviously any such effect would be most marked in England, S.W.

(4) The isophenes (lines of equal flowering date) have for the first time been tested for agreement with Prof. Hopkins's Bioclimatic Law, recently formulated and found to hold well in the United States. Starting from a given station, this postulates a retardation of four days in flowering for every additional 400 ft. of altitude, 1° of latitude and 5° eastward in longitude[2]; the reverse for negative values. Both he and we have found it fairly trustworthy for the British Isles, and he for Western Europe. This has enabled me to reduce the records to sea-level, so as to see whether there is any factor other than the higher elevations along most of the way until London is approached.

(5) Since it is most difficult faithfully to record the *average* date of first flowering, after taking the mean of the three trees for each of the thirty-five stations available (those within twelve to fifteen miles of the selected railway routes), the mean of two or more adjacent stations was taken, so far as possible. In this way we have fifteen sets of records available.

(6) Unfortunately the L.S.W.R. route from Exeter to London was useless, no records being available between Exeter and Fleet.

The results are shown in the following table:—

Mean Flowering Date, Sloe, Chestnut, May, 1920.

	Stations	Date
I.	Penzance, Camborne, Falmouth ..	April 8
II.	Polperro (2), Duloe	,, 6
III.	Launceston, Hexworthy, Tavistock ..	,, 6
IV.	Tiverton, Wellington, Taunton	March 30
V.	Winscombe, Portishead	April 2
VI.	Falfield, Bath	,, 1
VII.	Winsley, Marlborough	,, 6
VIII.	Oxford (2)	,, 3
IX.	Fleet, Farnham, Hampton Wick ..	March 29
X.	A. Harrow, Watford	April 9
	B. Purley (Surrey) (2)	,, 3
XI.	A. New Barnet, Woodford	,, 2
	B. Hayes and Bromley (Kent)	March 28
XII.	A. Maldon, Hatfield Peverel, Lexden ..	April 5
	B. Maidstone	,, 2

I. to IX. closely follow the G.W.R. from Penzance to London; X.A, XI.A, and XII.A continue on north of the Thames Estuary to Colchester; X.B, XI.B, and XII.B south of it to Maidstone.

Of I. to IX. the earliest date is just before reaching London; the latest in the foot of Cornwall. East Devon and Somerset fall little behind London; whilst East Cornwall, West Devon, and North Wilts are nearly as late as I. Hopkins's latitude and longitude corrections, however, intensify the contrast, the date relative to London working out to April 18.

Eastwards from London flowering dates north of the Thames are retarded, but to the south scarcely at all, Hayes and Bromley (Kent)—March 28—having the earliest date of all.

Before considering possible explanations, two cautions must be reiterated. The transfer here of Hopkins's Law values is still only tentative, and the dates of observation may well be subject to a margin of error of a day or two. Making full allowance for these, we may still believe that general observation is verified, the more so that,

[1] See our Phenological Report to the Royal Meteorological Society for 1920 (Part 3), 1921.

[2] As a fact, the law is more general, governing all seasonal plant phenomena; the regressive phases, of course require the reverse of the above statement.

as noted already, the earliness of 1920 was most strongly marked in England, S.W. We therefore conclude that London is at least a week earlier than Penzance in its fruit flowering; also that, at any rate in an early season, while further advance eastward south of the Thames estuary results in little change, there is a decided retardation on the opposite bank as one proceeds in a north-easterly direction. It is difficult to account for the Harrow-Watford delay. Further on the cooling influence of the North Sea and of east winds may come into play. The isophenes cut the East Coast, the direction varying N.E. to N. East-wind exposure may partly account for the retardation at Purley (Surrey) and on the Wiltshire downs. It is not easy offhand to suggest the reason affecting the extreme south-west, which must be largely influenced by ocean conditions. One would expect the fruit-flowering season to share in the relative earliness shown by the means of all twelve flowers (omitting ivy), ranging from February 6 to July 15. One may, however, note that, for the first six months, isotherms and isohels taken together slightly favour the London area, but in April the reverse was the case.

The East Devon and Somerset earliness was fully expected. Each year the isotherms show a remarkable uprush of warmth along the Severn sea and watershed and a corresponding lie of the isophenes. In 1920 the isotherm bulge reached the borders of Yorkshire.

Having thus considered the query raised, an extension of the subject may be of interest along two other lines through London, which I have worked out for the sake of comparison. These are: (1) The L.B.S.C.R. from the Isle of Wight and on by the East Coast route to Edinburgh and Ross-shire; (2) from East Sussex and on by the West Coast route to the Glasgow district. Round London much the same stations come in along all three lines. The comparison is best made by placing the two series side by side, arranged roughly by latitude (50¾° to 57¾°). The numbers in brackets show the number of stations in each group.

As one expects, both series give a decided delay with latitude and longitude. Hopkins's corrections for these from London to Ardross Castle (+6¼° and +4°) give the relative date for the latter April 18. For Glasgow (4½° and 4°) we get April 26, the value round the Firth of Forth (4½°, 3°) being April 12.

Either Hopkins's Law needs modification for the period in question, more than is indicated by the whole period, or there are special influences at work, such as oceanic effects, prevalence of east winds, and propinquity of hill and mountain masses. Nor need these be mutually exclusive.

To investigate them more complete data are required. For instance, we hope shortly to have mean values for a considerable number of stations over the thirty years of our records. The most obvious effect at present is perhaps the retardation for the spring period in question, due to high elevation, and even more the propinquity of hill and mountain masses. Is this due to the lag effect of their winter cooling? Snow would still be lying on the Welsh mountains in blackthorn days.

May I, in conclusion, direct the attention of readers of Nature to the need for yet further observers, especially in the districts indicated by the lacunæ in the tables and the fact that the L.S.W.R. from Exeter could not be used? Either my colleague, Mr. H. B. Adames (33 Holcombe Road, Ilford), or myself (Asgarth, Purley) will gladly give further information, or observing forms can be had direct from the Assistant Secretary of the Royal Meteorological Society, Cromwell Road, S.W.7. When we see the prominent position elsewhere, especially in the United States, taken by phenological work in its bearing on horticulture and agriculture, we realise the need in this country for greater unification in and concentration on its investigations.

Since the above was in print Prof. Hopkins has sent us the typed copy of an unpublished exhaustive discussion of the bioclimatic association

Mean Flowering Date, Sloe, Chestnut, May, 1920.

East Coast Route (41 stations)		Latitude	West Coast Route (45 stations)	
Groups	Date		Groups	Date
Hants and W. Sussex coastal (9) ..	April 4	50¾°	Sussex, etc. (4)	April 8
S.W. and S. London area (6)	March 31		S.E. and S. London (3)	,, 2
N. London area (3)	April 5	51½°	N.W. London (3)..	,, 5
			Herts (4)	,, 10
Herts to Northants (4)	,, 5½		Bucks and Oxon (4)	,, 8
		52¼°	S.E. Warwick, etc. (7)	,, 11
			Birmingham district (3)	,, 18
			N. Welsh coastal (4)	,, 18
			Cheshire (2)	,, 8
North Notts and Lincs (3)	,, 10	53½°	S.W. Lancs (3)	,, 16
Central Plain, Yorks (4)	,, 10		N.W. Lancs and Lakes (5)	,, 24½
Durham and Northumberland (4) ..	,, 28½	54¾°	Wigtown (1)	May 14
Firth of Forth coastal (7)	,, 27	56°	Glasgow district (2)	,, 11
Ardross Castle (1)	May 15	57¾°		

between North America and Eurasia. He has correlated the two continents by using for the four years 1916–1919 the flowering date of hawthorn, *Crataegus oxyacantha*, at our station of Tenbury, Worcestershire, with the date for the leafing of the hickory, *Carya alba*, at his own station of Kanawha Farm, West Virginia, adopted as base for intercontinental correlations. Working from the latter, he found the closest agreement with our 25-year mean; less divergent, he considers, than errors of observation.

In order to test his calculation, and again starting from his U.S.A. base, Prof. Hopkins worked out the theoretical means for the eleven British meteorological districts. Scotland N. and Ireland S. differed by 11 days, Scotland W. by 5. These three districts are our worst, from paucity of observers. But this year we have completed (see Q.J. Roy. Met. Soc. for October last) the 30-year mean values, worked out entirely afresh and carefully weighted for defective records. Compared with these far more trustworthy figures, the discrepancies found by Prof. Hopkins are reduced to three, one, and four days respectively, the eight other districts also giving closer agreements. Thus, though as yet unknown to Prof. Hopkins, his results are well confirmed.

The success obtained seems to imply that from absolutely trustworthy phenological records of seasonal changes for a single station in the northern hemisphere for one single plant, the whole seasonal phenology for any other plant or crop can be postulated for any other spot in North America, Europe or Asia. The publication of this paper should be an important step in this branch of applied science.

Obituary.

Dr. James Francis Bottomley.

By the death of Dr. Frank Bottomley—due to pneumonia following influenza—which occurred on January 16 at the early age of forty-seven, the country has lost the services of a chemist, physicist, technician, negotiator, and manager of men of quite exceptional ability and integrity.

Heredity and environment conspired to make Dr. Bottomley a man of science. His great-grandfather was Dr. James Thomson, professor of mathematics in Glasgow University; his great-uncles were Lord Kelvin and James Thomson, F.R.S., professor of engineering in Queen's College, Belfast, and Glasgow University; while his father was the present Dr. James Thomson Bottomley, F.R.S., of Glasgow University. His mother died when he was three years old, but five years later his father married the widowed sister of Lord Kelvin, and between the boy and his stepmother there arose an attachment which deeply influenced his character.

From eight to thirteen years of age Dr. Bottomley was educated at Bloxham, near Banbury, where he became interested in science, but his school career was cut short by influenza in the epidemic of 1888. After a long period of convalescence he entered the University of Glasgow—first as a non-matriculated, and afterwards as a matriculated, student—under Prof. Ferguson, Lord Kelvin, and Prof. Jack. In his second year he was laid up with scarlet fever and so lost the chance of taking his degree. In 1894, at nineteen years of age, he went to Germany, and, after about six months with a German family, entered the University of Heidelberg. Here he came under the influence of Victor Meyer and Prof. Gattermann, and also studied physics under Prof. Quincke, mathematics under Prof. Konigsberg, and mineralogy under Prof. Rosenbusch. In 1897 he obtained the Ph.D. degree "multa cum laude," and returned to Glasgow, where he entered the university chemical laboratory and physical laboratory.

In 1898 Dr. Bottomley was awarded a research studentship for three years, the first of which he spent at Glasgow, the second at Owens College, Manchester—where he was elected research student and afterwards research fellow under Prof. W. H. Perkin—and the third at University College, London, under Sir William Ramsay. Here, according to Ramsay, he showed "manipulative skill of the highest order," and proved himself "an accomplished chemist and a courteous gentleman." In 1901 he joined the standardising laboratory of Kelvin and James White, and a year later was associated with the Newcastle-upon-Tyne Electric Supply Co., and became also chemical expert to the firm of Merz and McLellan (then C. H. Merz), consulting electrical engineers.

In 1902 Dr. Bottomley began his great work on silica fusion on a commercial scale by means of the electric furnace. The research was carried out at Wallsend, and by skilful and systematic experiment he eventually solved the many technical difficulties which had defeated prior experimenters, and, as managing director of the Thermal Syndicate, Ltd., became responsible for the commercial, as well as for the scientific and technical, development of the work. In 1910 his company received the gold medal for its exhibit of fused silica ware (vitreosil) at the Brussels Exhibition, and the gold medal for a similar exhibit at Turin in 1911.

In 1914 the process, which was by this time well established, afforded almost the only material then manufactured in the United Kingdom in which acids could be concentrated for the manufacture of explosives. The output of the works was increased tenfold, and the burden of designing and supervising the necessary extensions and of the technical management fell, for the most part, on Dr. Bottomley. So successful was he as a manager that throughout the war and up to the time of his death the works were entirely free from labour troubles. After the armistice he was mainly occupied in

developing methods of manufacture of vitreosil globes for incandescent gas lighting, which he brought to a successful conclusion only shortly before his death.

Quiet and diffident in manner, slight in build, and far from robust, Dr. Bottomley gave little outward sign of the strength that was in him both of character and ability, and as he published but little and never advertised himself at all, he was not well known except to his associates. By these he was recognised as a man of exceptional judgment, business ability, and integrity, and, besides "being" the Thermal Syndicate, he was a director of Kelvin, Bottomley, and Baird, of Chas. Tennant and Co., and of the Blagdon Manure and Alkali Co. He was also (until the war) a director of the Deutsche-English Quartz Schmeltz G.m.b.h., which carried on the quartz fusion processes in Germany.

Dr. Bottomley was married in 1913 to Miss Dorothy Couves, and leaves a widow and two children. He was an outstanding example of the advantage of giving administrative and business responsibility to a man of character and scientific training. R. A. S. Paget.

Prof. Max Verworn.

By the death of Prof. Max Verworn at Bonn on November 23 last, a notable figure, who could ill be spared on account of the breadth of his outlook, has been lost to biology. Verworn had just completed his fifty-eighth year, having been born in Berlin on November 4, 1863. He received his school and early university education in his native city, and graduated Ph.D. in Berlin in 1887, and later M.D. in Jena in 1889. After graduation in medicine, his interests being then largely zoological, he paid a long visit to Villefranche and Naples, and later continued his investigations along the coast of the Red Sea. On his return to Jena Verworn was appointed assistant in the Physiology Institute, and in 1891 was duly approved as *Privatdozent*. After a few years' work, including a second visit to the Red Sea, he became extraordinary professor of physiology in Jena in 1895. In 1901 he was called to Göttingen as professor of physiology, and in 1910, on the death of Pflüger, he became the professor of physiology at Bonn. Verworn received many academic distinctions. In this country he was an Sc.D. of Cambridge and an LL.D. of St. Andrews. He was also an honorary or corresponding member of many of the Continental scientific societies, in Moscow, Vienna, Rome, Halle, etc. Twice he was invited to visit America, on the second occasion as Silliman lecturer in the University of Yale.

Verworn owed his special, almost unique, position in physiology to the catholicity of his interests. He had been impressed from his earliest student days with the value of zoology, and much of his best and most original work was done in the physiology of the invertebrates of all classes, although perhaps those of the marine fauna engaged his warmest attention. He used this material with skill and ingenuity in his interpretation of physiological problems in general. Undoubtedly the work by which Verworn is best known is his "Allgemeine Physiologie," which was translated into English by Prof. Lee. This book, which is a mine of information in the lesser-known aspects of general physiology, appeared in 1894, and was immediately recognised as a work of outstanding merit. It has gone through many editions. His Silliman lectures on irritability brought together his special views on the nature and function of the nervous system, a subject which had interested him from the first; indeed, one of his earliest contributions (in 1889) to attract attention bore the title "Psychophysiologisch Protistenstudien." He also held very definite views on the functioning of living tissue in general, and his name will always be associated with his interesting biogen hypothesis.

That Verworn's interests were not confined to the study, in any strict sense of the word, of ordinary physiology and zoology is evidenced by his writings on the psychology of primitive art and on the evolution of the human spirit. Certainly for many years before the war he was very interested in archæological and ethnological problems, and the writer has a most vivid memory of a conversation with Verworn, in which he gave an extraordinarily enthusiastic account of a visit to several of the Indian tribes resident in the south-west of the United States. He had visited these tribes to study the nature of their art, more particularly their colour combinations. Verworn also had a profound knowledge of the history of early art in Europe, and a very genuine interest in numismatics.

In spite of his many interests, Verworn managed to edit, with success, two physiological journals, one the *Zeitschrift für Allgemeine Physiologie*, founded by himself, and later, after his appointment to Bonn, the famous Pflüger's *Archiv*. E. P. C.

Col. Willoughby Verner.

Col. William Willoughby Cole Verner, who died on January 25 at his home at Algeciras, was in many ways a remarkable man. He was a product of the Army at its best and a living denial of the too-often-quoted saying that Army officers think little and have no interests beyond sport and their "shop." Col. Verner will be remembered not only as the writer of the history of the Rifle Brigade and as the inventor of the luminous magnetic and prismatic compass and of other aids for military sketching and surveying, but also as an authority on the wild birds of South Spain and the discoverer of many of the rock shelters in South-West Spain that had been painted and decorated by Neolithic or Eneolithic man. Articles on the latter were published by him in the *Saturday Review*, and these brought him into relationship with the Abbé H. Breuil. The result was a careful survey of the whole district with regard to prehistoric man. Col. Verner, while bird-hunting near Ronda, had once noticed paintings on the walls of a cave near the top of the "sierra." This led to the publication by Breuil, Obermaier, and Verner of the first of an interesting group of Palæolithic cave paintings, which recall the northern group of France and Cantabria. But the memory of Col. Verner

will always live in the hearts of those who were privileged to be with him for a time at his little shooting cottage near the Laguna de la Janda. His kindness, knowledge, and interest in everything were especially noticeable, but at the same time his soldierlike love of order was never absent. Woe betide the guest who returned the salt-jar to the place where the pepper-pot should have been! The Army has lost a competent officer who continued to work for it in many ways after being physically incapacitated during the South African War from active service; science has lost an earnest follower; but, above all, some of us have lost a real friend.

M. C. BURKITT.

Current Topics and Events.

SIR FRANCIS GALTON was born on February 16, 1822, in the same year as Mendel. The Eugenics Education Society is celebrating the anniversary in a dignified way with addresses on Galton's contributions, not only to eugenics, the cause that was nearest his heart, but to statistics and geography as well. Galton was in more than one striking way the complement of his cousin, Charles Darwin, but especially in this respect: that his imagination was fired with the idea of man's evolution going on. Darwin thought more perhaps of the descent of man, Galton of the ascent; but it is very interesting that the *doyen* among eugenists should be Darwin's own son. The Eugenics Education Society has been fortunate in having had Major Leonard Darwin for many years at its helm. Of course, Charles Darwin and Francis Galton were entirely at one, though the angle from which they regarded man was a little different. What Galton grasped so firmly was the idea of *man evolving*, and that no longer mysteriously, but under the influence of factors which are discoverable by, and amenable to, scientific methods. He had the vision of the control of life, of applying our knowledge of the factors in evolution to the guidance and acceleration of that evolution. This was to him, as he said, "a virile creed, full of hopefulness, and appealing to many of the noblest feelings of our nature." In celebrating the anniversary there is reason for congratulation and encouragement, for Galton's doctrines have made rapid headway. It must be confessed, however, that the need for more enthusiasm is great. Thus we see from Prof. Karl Pearson's letter to the *Times* of January 18 that although the Galton Laboratory is nobly housed, its undertakings—especially in the way of publication—are sadly hampered by lack of funds. The same hindrance affects the Eugenics Education Society, and it is plainly a matter for regret that new knowledge of high importance should be lying unpublished and that educational efforts to diffuse the "virile creed" should have to be slackened when they are so urgently needed.

ON February 19 occurs the tercentenary of the death of Sir Henry Savile, to whom Oxford owes the foundation of the Savilian professorships of geometry and astronomy. Accounted by his contemporaries—among whom were Casaubon and Scaliger—"a man of admirable skill in the Greek and Latin languages and a laborious searcher and generous publisher of the remains of venerable antiquity," Savile was one of the first scholars of the age. Born near Bradley, Yorkshire, in 1549, he matriculated at Brasenose College, became a fellow of Merton College, was elected a proctor of the University, and at one time taught Greek to Queen Elizabeth. From 1585 he was Warden of Merton, and from 1596 Provost of Eton, holding both positions until his death, which took place at Eton. The chairs of geometry and astronomy were founded by him in 1619, Briggs being appointed to the former and Bainbridge to the latter. Among the distinguished men who have held one or the other have been Halley, Sir Christopher Wren, Bradley, Baden-Powell, Pritchard, H. J. S. Smith, and Sylvester. Before Briggs took over the duties of the chair of geometry Savile himself delivered thirteen lectures upon the first eight propositions of Euclid's "Elements," and these were published in 1620. Though Savile's contemporary, Sir Henry Billingsley, sheriff and Lord Mayor of London, had published the first English translation of Euclid's "Elements" in 1570, and the chair of geometry at Gresham College had been founded in 1596, the preamble to the deed of foundation of the Savilian professorships stated that "geometry is almost totally unknown and abandoned in England."

A BILL was introduced in Parliament on February 8 providing that summer time should begin on the last Saturday in March (or, if that is Easter Eve, on the preceding Saturday) and end on the first Sunday in October. These dates have been fixed in agreement with France and Belgium, as a difference in the dates causes confusion in through services. Many astronomers suffer some inconvenience from the use of summer time, but probably most of them would make little of this if they were persuaded that the majority of the community recognised it as a boon. All must agree that, if used, it is well to have its beginning and end fixed in a regular manner. On theoretical grounds, of course, the principle of summer time does not differ from that accepted long ago, when Greenwich time was introduced for the whole of Great Britain. This involved the use of a standard meridian, differing for some places 7° from the local one, and the increase from 7° to 22° is a matter of convention; the first has no more basis in theory than the second. On scientific grounds the main objection to summer time is the confusion due to the varying standard, and the measure now proposed should do something to remove the difficulties thus caused.

ON January 24 Mr. T. East Lones, of the Patent Office, read a paper before the Newcomen Society on "Mechanics and Engineering from the Time of Aristotle to that of Archimedes." Aristotle contains little of interest to engineers, but it was the extraordinary

belief in his views that led to the trouble after Galileo, by his experiments from the Leaning Tower of Pisa, had shown the falseness of Aristotle's dictum that the velocity of a body falling in a given medium was proportional to its weight. The works of Archimedes are of a much more valuable nature. His solution of problems regarding floating bodies, his determination of the centre of gravity of various surfaces, his invention of the Archimedean screw, and his investigation of the lever place him among the greatest pioneers in the acquisition of knowledge. Though it is generally believed that Archimedes asserted that he could move the earth with a lever had he a place to stand upon, it appears that Archimedes contemplated the use of compound pulleys for this purpose, and not the lever. After referring to the engines of war of those days, Mr. Lones gave interesting details of the two great aqueducts which led water into Rome, the old Roman roads, and other civil engineering works. He also referred to the tools used by the ancients in the execution of their works.

In an article in the *Quarterly Review* for January Mr. E. Howell discusses at length the problems connected with river control in Mesopotamia. The Tigris and Euphrates are exceptional rivers in the way that their lower reaches break down, throwing off effluents, although eventually they unite and enter the Persian Gulf through a single mouth. Between Bagdad and Ezra's Tomb, a distance of some four hundred miles, the Tigris receives only two tributaries, but throws off five huge effluents besides innumerable smaller channels. The Euphrates in the same portion of its length shows even more marked degeneration, breaking into a thousand petty waterways in the tract known as Shamiyah, reuniting near Shamawah, and again spreading into a waste of shallow waters in Lake Hammar. There seems to be much evidence that this state of affairs is the outcome, not of natural causes, but of man's interference with the river acting through long ages and accentuated by the difference in both rivers between the levels of low water and high flood. It is suggested that if this interference is scientifically regulated the rivers will revert to former conditions, in which their value to man will be greatly enhanced in respect of definite channels and deeper beds. Unregulated riparian cultivation for ages has resulted in the formation of many effluents and the blocking of the river-bed by silt dug from the channel at low water in the construction of the irrigation canal from the shrunken river to the squatter's date-grove. Mr. Howell, quoting Major Walton, explains the process in full, and contends that the remedy lies in the control of riparian cultivation, the regulation of the course and nature of irrigation channels, and the construction of dams or locks on the chief effluents. Some work of this nature carried out from 1916 to 1919 has had noticeably beneficial results on the navigability of the Tigris.

From the report on the administration of the Meteorological Department of the Government of India in 1920–21 it appears that the suspension of wireless telegraphy from ships at sea during the war has rendered it more difficult to give information as to the development and path of storms. The system was started again in May, 1920, although it will necessarily take time to regain the former efficiency. The absence of such wireless information apparently led to wrong deductions relative to the movement of a storm in the Arabian Sea between June 6 and 13. There was, fortunately, little loss of life, but in Junagadh State the storm did a large amount of damage; 16,000 houses are said to have fallen, 22,000 trees were uprooted, and 7700 cattle died. Upper-air observations are being made in connection with military flying on the part of the Royal Air Force and for the use of civil aviators when the route Bombay–Calcutta–Rangoon is opened. The number of special forecasts and warning messages sent from Simla during the year was 2994, and from Calcutta 929. In connection with cases of heatstroke among British soldiers, information was supplied to local medical authorities when the wet-bulb temperature rose above 75° F. Registration of rainfall has been carried out during the year at 2915 stations, for which the returns are published. The growth in departmental activity and changes in total cost are shown by diagram for the last thirteen years. Mention is made of the loss to the Indian Service of Dr. G. C. Simpson through his appointment as Director to the Meteorological Office of the Air Ministry.

The Royal Astronomical Society was founded as the London Astronomical Society in February, 1820, but did not gain the prefix "Royal" until 1830. At the annual general meeting of February, 1920, the president, Prof. A. Fowler, gave an address on the origin and early days of the society, which had Sir W. Herschel for its first president. There was some opposition to its formation on the part of the Royal Society, but this did not last long. The centenary of the society will be celebrated next June; it will open with a conversazione on the evening of June 8. On June 9 there will be an historical meeting in the morning and a scientific one in the afternoon; at the former three addresses will be given, one introductory by the president, an historical address by Dr. Dreyer, and a biographical address by Prof. Turner. The society will dine together in the evening. A volume dealing with the history of the society is in course of preparation, and may be issued during the year. It is divided into ten decades, and is the work of several collaborators, but Dr. Dreyer, who is well known as an astronomical historian, has contributed the largest share. It will be illustrated by portraits of some of the more celebrated presidents of the society.

The *Times* of February 13 makes the following announcement:—A Committee has been appointed to discuss the co-ordination of the work of the various Admiralty chemical laboratories. It will consider the scope of all work now carried out at the various laboratories in the Admiralty service, and will report

whether any changes can be made with due regard to the requirements of each department interested in the work to avoid dissipation of energy, overlapping of duties, and unnecessarily different conditions of service. Mr. W. J. Evans, Director of Establishments, is chairman, and Mr. J. Lang, of the Admiralty C.E. Branch, is secretary; the other members being Eng. Vice-Adm. Sir George Goodwin, Engineer-in-Chief; Capt. R. R. C. Backhouse, Director of Naval Ordnance; Comdr. L. E. H. Llewellyn, Chief Inspector of Naval Ordnance; Mr. F. E. Smith, Director of Scientific Research; Mr. W. J. Berry, Director of Warship Production; and Mr. F. Ward, Deputy-Director of Armament Supply.

THE Fuel Research Board of the Department of Scientific and Industrial Research has appointed a Committee to advise upon the sampling and analysis of coal. The *personnel* of the Committee is as follows:—Prof. T. Gray (chairman), Prof. J. W. Cobb, Mr. J. T. Dunn, Dr. J. S. Flett, Mr. G. Nevill Huntly, Mr. S. Roy Illingworth, Mr. J. G. King, Dr. C. H. Lander, Dr. R. Lessing, Mr. C. A. Seyler, Mr. F. S. Sinnatt, and Prof. R. V. Wheeler. Secretary, Miss N. Renouf. It is intended that the methods recommended by the Committee shall be adopted in connection with the physical and chemical survey of the national coal resources. Communications for the Committee should be addressed to the secretary at 16 and 18 Old Queen Street, Westminster, London, S.W.1.

WE are glad to see that the Portsmouth Literary and Philosophical Society, which was established in 1869 but was afterwards discontinued, has been revived. There must be many citizens of all classes in such a place as Portsmouth, with the adjacent residential district of Southsea, who will find interest and stimulus in the activities of the new society. The programme for the current session includes descriptive lectures, field excursions, and sectional meetings of students and workers in various departments of knowledge, such as literature, history, geography and geology, botany and zoology, psychology, and social science. The president, Sir Richard Gregory, will deliver his presidential address on "The Influence of Science" to-morrow, February 17. Mr. E. Heron-Allen, F.R.S., and Sir John Brickwood are vice-presidents of the society, Lt.-Col. J. H. Cooke chairman of council, and Mr. C. W. Ball, Whittington Chambers, King's Road, Southsea, honorary secretary.

CONTINUING its discussion of the State and provincial museums, the *Museums Journal* in its February issue suggests that this country is not merely falling behind others, but has even taken a step backward. "The post created for dealing with provincial museum work at the Board of Education has now been vacant for more than a year." The regulations formerly "laid before Parliament annually, as part of a Board of Education command paper, setting forth the conditions upon which loans of objects and grants of money were made to provincial museums, were last issued in 1910." These alleged facts seem curiously inconsistent with the activity of discussion on the educational use of museums that prevailed a few years ago at the Ministries of Reconstruction and Education. This is not altogether to be explained by the necessity for economy, since what is wanted is not so much fresh expenditure as the co-ordination and utilisation of the means ready to hand.

DONATIONS to the Maidstone Museum during the past year include an albino specimen of the American grey squirrel, shot near Maidstone; a lower jaw of the woolly rhinoceros found in Maidstone, and remains of the cave lion and the mammoth from the river-drift at Aylesford; a miscellaneous collection containing many fine minerals, formerly the property of Prof. Arthur Connell, F.R.S., of St. Andrews; fragments of a baked earth bowl associated with a calcined flint nodule (? a pot-boiler) found at Borough Green; three pieces of Late Celtic pottery from the Cherry Orchard Estate, near Maidstone; and a copy of William Smith's "Delineation of the Strata of England and Wales, etc.," published in 1815. The large number of other donations bears witness to the confidence placed in the curator, Mr. J. H. Allchin.

As from April 1 next, the importation into the United Kingdom of the plumage of birds not expressly excepted under the Importation of Plumage (Prohibition) Act, 1921, will be prohibited. The Board of Trade may, however, under section 2 (4) of the Act, "grant to any person a licence subject to such conditions and regulations as they may think fit authorising the importation of plumage for any natural history or other museum, or for the purpose of scientific research or for any other special purpose." All applications for licences under this sub-section should be addressed to the Imports and Exports Licensing Section, Board of Trade, Great George Street, Westminster, S.W.1.

THE annual meeting and excursions of the Somersetshire Archæological and Natural History Society will be held at Clevedon on July 4–6. The president-elect is Sir William Boyd Dawkins.

MR. G. V. COLCHESTER has been appointed to the post of geologist on the Geological Survey of the Anglo-Egyptian Sudan in succession to Mr. C. T. Madigan, who now holds a lectureship in geology at Adelaide University.

AT a meeting of the Institution of Automobile Engineers on February 8 Mr. E. L. Bass read his paper on "Engine Lubrication," for which the Daimler premium for the session 1920–21 was awarded. Lt.-Col. D. J. Smith was elected president for the session 1922–23.

ON Tuesday next, February 21, Sir Arthur Keith will begin a course of five lectures at the Royal Institution on "Anthropological Problems of the British Empire," Series 1: Racial Problems in Asia and Australasia. The Friday evening discourse on February 24 will be delivered by Prof. J. Joly on "The Age of the Earth."

THE thirty-first annual meeting of the Royal Society for the Protection of Birds will be held at the Middlesex Guildhall, Westminster, S.W.1, on Tuesday,

February 21. The chair will be taken at 3 p.m. by the Duchess of Portland, and an address on the work of the society will be delivered by Viscount Grey of Fallodon.

AT the annual general meeting of the Royal Meteorological Society on January 18 the following officers were elected:—*President:* Dr. C. Chree. *Vice-Presidents:* Mr. C. L. Brook, Mr. W. W. Bryant, Mr. R. H. Hooker, and Dr. E. M. Wedderburn. *Treasurer:* Mr. W. Vaux Graham. *Secretaries:* Mr. J. S. Dines, Mr. L. F. Richardson, and Mr. Gilbert Thomson. *Foreign Secretary:* Mr. R. G. K. Lempfert. *Council:* Dr. J. Brownlee, Mr. D. Brunt, Mr. C. J. P. Cave, Mr. J. E. Clark, Mr. R. Corless, Mr. Francis Druce, Mr. J. Fairgrieve, Col. H. G. Lyons, Mr. Henry Mellish, Sir Napier Shaw, Dr. G. C. Simpson, and Mr. F. J. W. Whipple. Communications should be addressed to the secretaries at 49 Cromwell Road, South Kensington, S.W.7.

THE following officers and members of council of the Royal Astronomical Society were elected at the anniversary meeting on February 10:—*President:* Prof. A. S. Eddington. *Vice-Presidents:* Dr. J. L. E. Dreyer, Sir F. W. Dyson, Prof. A. Fowler, and Prof. H. F. Newall. *Treasurer:* Col. E. H. Grove-Hills. *Secretaries:* Dr. A. C. D. Crommelin and the Rev. T. E. R. Phillips. *Foreign Secretary:* Prof. H. H. Turner. *Council:* Prof. A. E. Conrady, Dr. J. W. L. Glaisher, Mr. P. H. Hepburn, Mr. J. Jackson, Dr. H. Jeffreys, Prof. F. A. Lindemann, Dr. W. H. Maw, Prof. T. R. Merton, Prof. J. W. Nicholson, Mr. J. H. Reynolds, Lt.-Col. F. J. M. Stratton, and Mr. H. Thomson.

THE annual general meeting of the Physical Society of London was held on February 10, and the following officers and members of council were elected:—*President:* Dr. A. Russell. *Vice-Presidents:* Lord Rayleigh, Prof. T. Mather, Mr. T. Smith, and Prof. G. W. O. Howe. *Secretaries:* Mr. F. E. Smith, "Redcot," St. James's Avenue, Hampton Hill, and Dr. D. Owen, 62 Wellington Road, Enfield. *Foreign Secretary:* Sir Arthur Schuster. *Treasurer:* Mr. W. R. Cooper. *Librarian:* Dr. A. O. Rankine. *Other Members of Council:* Mr. C. R. Darling, Prof. C. L. Fortescue, Dr. E. Griffiths, Dr. E. H. Rayner, Mr. J. H. Brinkworth, Mr. J. Guild, Dr. F. L. Hopwood, Dr. E. A. Owen, Dr. J. H. Vincent, and Dr. G. B. Bryan.

A TRANSLATION of the Nobel Prize address delivered by Prof. Max Planck before the Royal Swedish Academy of Sciences on "The Origin and Development of the Quantum Theory" will be published at an early date by the Oxford University Press.

READERS in search of book bargains should see Catalogue No. 454 of Messrs. William Glaisher, Ltd., 265 High Holborn, W.C.1, and Catalogue No. 424 of Mr. F. Edwards, 83 High Street, Marylebone, W.1, in which are to be found the titles of many science books offered at greatly reduced prices. The works in the first-named list are publishers' remainders; those in Mr. Edwards's are second-hand.

Our Astronomical Column.

FIREBALL OBSERVED IN SUNSHINE.—Mr. W. F. Denning writes that on February 7, at 3.55 p.m., he observed a brilliant fireball descending in the northern sky. The sun was shining at the time, and the firmament was almost cloudless. The fireball moved with moderate speed, varying in size and lustre as it fell, and its motion was directed to the north-north-west point of the horizon, but it disappeared when 21° in altitude. Its brilliancy was such that had it appeared at night the heavens would have been strikingly illuminated. The fireball was observed from other places, and it appears certain that it was moving from a radiant point near the star Capella. There is a well-known shower of brilliant meteors from this region in the month of February. It is hoped that further observations of the recent fireball will come to hand so that its height, velocity, and exact direction may be computed.

A PRINTING CHRONOGRAPH.—The printing chronograph was invented by Prof. G. W. Hough, of Dearborn Observatory, in 1885. It is briefly described by Prof. Sampson in the Monthly Notices, R.A.S., for April, 1903. Its use leads to a decided increase of accuracy in the recording of transits or other time observations as compared with older forms of chronograph. This becomes of particular importance now that the use of the recording micrometer has considerably reduced the errors in the signals sent from the telescope to the chronograph.

The Société Genevoise, 95 Queen Victoria Street, E.C.4, is now showing a new printing chronograph. There are three discs, marking minutes, seconds, and hundredths, which revolve in an hour, a minute, and a second respectively; the first has to be set by hand to agree with the clock; the adjustment of the others is effected automatically. When a signal is sent the discs are pressed momentarily against a typewriting ribbon, behind which is a paper tape; the tape is moved automatically after each signal; there is thus no waste of paper between the signals, and a night's record is comprised in moderate limits; this counterbalances the greater awkwardness of a tape record as compared with a cylindrical one for a long night's work. The discs are electrically driven by a motor the E.M.F. of which is 12 volts, supplied by secondary cells. The net weight of the installation is 66 lb., and gross weight 110 lb.

NOVA PUPPIS 1902.—The *Gazette Astronomique* for December last records the discovery of a new star by Miss Woods from the negatives taken at the Harvard Observatory. The position of the nova was R.A. 8h. 9m. 36·4s., decl. −26° 15·8′ (1900); the star was thus situated on the fringe of the Milky Way, the region in which novæ are usually found. The following is a summary of the facts recorded:—1901 (invisible), <16 mag.; 1902, September 24, <10·3 mag.; November 19, 7 mag.; December 6, 7 mag.; 1903, June 3, 10·5 mag.; and 1905, <14·5 mag. (invisible afterwards). More than 400 negatives of the region were examined. Judging from the facts recorded, it looks as if the nova reached its maximum some time before November 19, 1902, because it is not usual for new stars to maintain their maximum magnitude for such a long period as seventeen days. No photographs of the spectrum were taken.

Research Items.

Birthdays in Relation to Intelligence.—In the Proceedings of the Royal Society of Edinburgh (vol. 41, No. 17) Mr. M'Callum Fairgrieve discusses the annual incidence of intelligence. He experimented with 368 boys, using chiefly the American Army tests, supplemented by some of the tests used by Dr. Cyril Burt. His object was to see whether the time of year of birth bore any relation to intelligence. The results seem to show that boys born in the late spring months are in danger of developing less intelligence than those born about October. It is pointed out that naturally there are exceptions, some of the clever boys having birthdays in the less intelligent period, but that on the whole, and his ages range from ten years to eighteen years, the generalisation is correct. The author suggests that it would be valuable if the test were repeated in other districts. Certainly it is a problem worth studying systematically.

Apogamous Reproduction.—In a short account of experiments in apogamous reproduction with some species of Hieracium, Dr. C. H. Ostenfeld (*Journal of Genetics*, vol. 11, No. 2) describes the occurrence of several apogamic mutants which remain true in apogamous reproduction. It is believed that the numerous microspecies in the subgenus Archieracium have been produced in this way, being the after-effects of earlier crossing. The cytological studies of Rosenberg with species of this group have shown that there are irregularities in the chromosome distribution during the reduction divisions. The occurrence of apogamic mutants is plausibly accounted for on the assumption that some such irregularity may occur in the development of the egg-cell, thus producing an aberrant individual which will breed true later by apogamous reproduction.

Sex-reversal.—In a very interesting paper on sex-reversal in frogs and toads Mr. F. A. E. Crew (*Journal of Genetics*, vol. 11, No. 2) discusses all the recorded cases of females exhibiting all intergrades towards the male condition. In extreme cases the transformed animal appears as a typical male, but may retain the Müllerian ducts or a few ova amid the spermatic tissues. Such an animal behaves and functions as a male, but that it retains the germinal constitution, *i.e.* the chromosome complex, of a female has been shown by crossing such a transformed female with a normal female. The young (774) were all females, showing that the chromosome complex of these "somatic" males had remained unchanged. The transformation acts through the internal secretions of the gonads, and the process of sex-reversal is very similar to that which causes the production of freemartins in cattle, as described by Lillie. The general opinion that Bidder's organ in the frog is a rudimentary ovary is questioned on the basis of these experiments.

Cotton in the French Sudan.—The shortage of raw cotton for the mills of France, due largely to the decreasing export from the United States, has directed attention to the possibility of large-scale cotton production in the French Sudan. With this end in view the Comité du Niger has been formed. Some details of the schemes which this committee proposes, together with a large-scale map, are given in *La Géographie* for December last. Briefly, the idea is to irrigate certain areas along both banks of the Niger in the vicinity of Segu, which it is proposed to connect by rail with both Grand Bassam and Dakar. On the left bank the Nyamina irrigation canal would leave the Niger near Bamako, the railhead of the line from Dakar. A barrage would be erected at Sotuba and another at Sansanding, some twenty-five miles below Segu, from which the Sansanding Canal would run eastward for about 140 miles. Land on the right bank is to be irrigated by the Segu Canal and its branches, which leaves the river at the Sotuba barrage. These schemes, if carried out in full, would give some 10,000 square miles of irrigated alluvial ground. Farther east along the Niger towards Timbuctu vast areas of useful land could also be reclaimed for cotton-growing.

Potash in Marl and Greensand.—The value of glauconitic marl and greensand as sources of potash is once more raised in the Annual Report for 1920 of the Department of Conservation and Development, New Jersey. At Elmwood Station, where green marl is 49 ft. thick, an acre of land covers approximately 9400 tons of potash. The average potash-content of the marl over a wide area is as high as 6·60 per cent.; but commercial development, unfortunately, awaits new methods of extraction.

Antarctic Geology.—Mr. J. M. Wordie's report (Trans. Roy. Soc. Edin., vol. 53, pt. 2, 1921, 4s.) on "Geological Observations in the Weddell Sea Area," in connection with the Shackleton Antarctic Expedition of 1914–17, is specially notable on account of its photographic illustrations. The view of South Georgia in Plate 1 provides an exceptionally fine picture of a land escaping from glacial control, with its high cirques in the background, frost-sculpturing on the arêtes, a valley glacier still pushing out to sea, and the bared bed of another, preserving the very form of the terminal fan, though the ice itself has shrunk back towards the hills.

Rainfall in Mysore.—Rainfall registration in Mysore for 1920 is the subject of a report by Mr. N. Venkatesa Iyengar, Meteorological Reporter to the Mysore Government. During the year rain was observed at 226 stations. The greatest rainfall recorded in one day was 11·88 in. at Agumbi, in the Shimoga district, on July 24; in the previous year the heaviest fall was 15·40 in. at Nagar on June 20. The mean rainfall for the year in the State was 28·96 in., whilst the average is 36·07 in.; in 1919 the mean for the State was 38·97 in. There was a deficiency of rainfall in 1920 in every district, ranging from 6 per cent. in the Shimoga district to 49 per cent. in Tumkur. Data are given showing the monthly rainfall for the several districts and the mean percentage departure from the average. Similar information is given for the seasonal rainfall, the four seasons into which the year is divided being cold-weather period, January and February; hot-weather period, March, April, and May; south-west-monsoon period, June, July, August, and September; and the retreating south-west-monsoon period, October, November, and December. In the hot-weather period, the south-west-monsoon period, and the north-east-monsoon period there was a general shortage of rain. Rainfall is collated for the several river-basins for 1920 and compared with the average fall for twenty-seven years, 1893–1919. The monthly average fall is given for each station. The average rainfall for the year ranges from 316·59 in. at Agumbi, in the Shimoga district, to 15·61 in. at Nayakanhatti, in the Chitaldrug district. The geographical distribution of rain in 1920 and the average are well shown in two maps at the end of the report.

Burst Tubes in the Claude Process.—In the synthesis of ammonia under pressures of 1000 atmospheres and at reaction temperatures of 500°–550° C., as in the Claude process, many working difficulties might have been anticipated One of these is described by M. Georges Claude in the *Comptes rendus* of the Paris Academy of Sciences for January 16. In the reaction between the hydrogen and nitrogen large amounts of heat are produced, and these were removed by the circulation of molten lead round the vertical reaction tubes. This system has led to accidents through bursting tubes, and it has been found that the crack starting the break in the tube always commences on the outside, and the effect is shown to be due to the difference of temperature between the inside and the outside of the thick-walled tube. This difference, about 200° C., causes the warmer internal layers to exert an enormous pressure on the cooler outer layers, and this is in addition to the normal pressure of working. The tubes are now packed in kieselguhr to prevent this dangerous temperature-gradient, and other means will have to be adopted to remove the heat set free in the combination of the two gases.

Industrial Motion Study.—Most of our knowledge of "time and motion" study comes from America, and is chiefly dependent on the investigations of F. W. Taylor and F. B. Gilbreth. The object in view was the standardisation of human industry. Taylor picked out his best workmen and determined the shortest times taken by them to perform the various stages of the industrial operation under investigation. The times were added together, and, after the addition of a certain allowance for unavoidable delays, they formed the standard time or task. This required the workman to do three or four times as much work per day as he had done previously without much regard being paid to his state of fatigue. Gilbreth gave more attention to the methods of work, and endeavoured to ascertain what were the quickest movements possible in the various steps of an industrial operation. These he regarded as the best. In Report No. 14 of the Industrial Fatigue Research Board Mr. Eric Farmer gives a full summary of previous work on time and motion study, and subjects it to severe criticism. As the result of his own observations in industries such as that of sweets production, he concludes that the most important principle of motion study is rhythm rather than speed. The best set of movements is not the quickest set, but the easiest set. The quickest set may cause too much strain on the workers and produce undue fatigue. It is better to make the movements of the hands required in an industrial operation in curves, without sudden changes of direction, rather than in straight lines. Increased production was not specially aimed at, though, as a matter of fact, it invariably occurred when a proper system of movements was introduced. In the instances quoted it went up from 38 to 50 per cent.

Alcohol as a Motor Fuel.—A brief survey of the work of the Fuel Research Board in regard to power alcohol since the publication of the Board's interim memorandum in 1920 is given in the second memorandum on "Fuel for Motor Transport," which has recently been issued. This publication contains the results of inquiries which have been made as to the possibility of producing commercial quantities of alcohol within the Empire at a price which would render its use practicable as a motor fuel. The facts that nearly all the vegetable substances proposed as raw materials for the manufacture of spirit are already in great demand as foodstuffs or for industrial purposes, and the usually high cost of production, provide the key to the main results of the inquiries. So far as the British Isles are concerned, there is little prospect of adding materially to the supplies of power alcohol from home-grown raw materials. The utilisation of molasses, however, in overseas countries where this by-product is not yet fully employed for other purposes, and the cultivation in the tropics of cêrtain roots and tubers with a high starch content, offer prospects of a limited production of alcohol which may be equal to no more than local demands. Synthetic production on a commercial scale in the British Isles is unlikely, but in Canada and Australia, especially in the latter country, the process is not impossible with the development of available sources of cheap electricity. The best chance of the production of power alcohol on a large scale for export appears to lie in the perfection of a chemical or bacteriological process for the production of alcohol from the inexhaustible supplies of vegetation in tropical and sub-tropical regions. The researches to this end initiated by the Board have not yet resulted in a practical commercial process, but some progress has been made, especially on the bacteriological side.

Endurance Limits of Metals.—During the recent war the question of the strength of aeroplane parts and other problems of materials under repeated stress brought the whole subject of "fatigue" phenomena of metals to the attention of the National Research Council, U.S.A. The result was the organisation of an investigation by the co-operation of this body with the Engineering Experiment Station of the University of Illinois. We have received Bulletin No. 124 from the University entitled "An Investigation of the Fatigue of Metals," which is a progress report of the first part of this investigation, having for its object the determination whether or not there exists any clearly defined relation between static properties and the ability to resist repeated stresses. The work has been carried out by H. F. Moore and J. B. Kommers. Two types of rotating-beam testing machines were used, one reversed bending testing machine, and one reversed-torsion testing machine. The materials tested consisted of both carbon and alloy steels, the range of composition in the former case being considerable The authors conclude that for metals tested under reversed stress there is a well-defined critical stress at which the relation between unit stress and the number of reversals necessary to cause failure changes markedly. Below this critical stress the metals withstood 100,000,000 reversals, and, so far as can be predicted from test results, they would have withstood an indefinite number of such reversals. The name "endurance limit" has been given to this critical stress. No simple relation was found between this and the elastic limit. Rather curiously, the Brinell hardness test appears to furnish the best index of this figure, the reason for which is by no means clear. The authors find that the endurance limit for ferrous alloys can be predicted with very fair accuracy by the measurement of the rise of temperature under reversed stress applied for a few minutes. This is the development of a test proposed by Mr. C. E. Stromeyer. In none of the alloys tested did the endurance limit under completely reversed stress fall below 36 per cent. of the ultimate tensile strength; for only one alloy did it fall below 40 per cent., while for several alloys it was more than 50 per cent. The tests reported indicate the effectiveness of proper heat treatment in raising the endurance limit of ferrous alloys.

The Air Conference.

IT is yet too early to judge of the effects on the future of aeronautics of the official and unofficial speeches made in the course of the Air Conference at the Guildhall, London, on February 7 and 8, but there can be no doubt as to the seriousness of the various speakers or the representative character of the gathering. The dominant note of the Air Minister's address was lack of belief in the future of civil aviation in Europe, an expression of opinion not shared by the members of the conference. It was asserted by more than one speaker that a subsidy is needed by the London–Paris air service only because France has given a large measure of assistance to her designers, constructors, and pilots. Whilst the British aircraft companies have carried six passengers per machine on each journey, the corresponding figure for French aeroplanes is two; on the other hand, the major portion of the goods traffic has been taken in the aircraft of other countries.

The conference was opened by the Secretary of State for Air, Major F. E. Guest, but for the greater part of its proceedings Lord Weir was in the chair. Matters relating to the Air Force were not under review, as at the previous conference—a development towards secrecy in the new fighting Service which may be noted. Provision was made for the reading of papers on the first day, the morning being devoted to civil transport and the afternoon to technics and research for both aeroplanes and airships. The second day was fully occupied by discussion from the assembled experts from the various branches of aeronautics. The depression produced by Major Guest was not removed by the carefully prepared paper read by Lord Gorell, the Under-Secretary of State for Air, and speaker after speaker was moved to protest. Lord Gorell's paper showed that air activity is great in many parts of the world, and that other countries are spending more money on development than is Britain. Probably Lord Weir voiced the general sentiments when he indicated a better quality for the endeavours of this country, and suggested that enough had been learnt to justify the development of the Imperial air route, England–Egypt–India. A permanent committee is now being formed to deal with the matter, and the only resolution put to the conference endorsed the view and was acceptable to the Air Ministry.

Col. Bristow, with an intimate knowledge of the working of the London–Paris air service, remarked that "it is lamentable in the extreme that in this year, the fourth after the Great War, the British commercial air fleet should consist, all told, of fewer than twenty aeroplanes; in fact, on the day the paper was written there were only six or seven."

The exhibits on the aerodrome at Croydon on the day preceding the conference must then have constituted the whole of the existing commercial air fleet, and the number may be contrasted with an output of 1000 aeroplanes per week at the close of the war. The smallness of the civil, as compared with the military, side was referred to by Sir Samuel Instone, of the Instone Air Line, on the following day, when he mentioned the fact that the subsidy for civil aviation is 200,000*l*., whilst the expenditure on the Air Force has been 18,500,000*l*.; of the 200,000*l*. it is proposed that the spending of half on new craft should rest with the Air Ministry, and not with the transport companies.

The discussion on this section of the subject (civil transport) turned on the importance of civil aviation to progress. There was a strongly expressed view that the new system of transport has come to stay, and the president of the Federation of British Industries attended the conference to give the blessing of the business community and to announce adherence to the theory of a sound subsidy in the early stages of development. That the industry will ultimately support itself on a commercial footing was not doubted, but no one accepted as satisfactory the statement of the Air Minister that in certain directions Britain could wait for ten years and then start again.

Where is the principal stumbling-block? The Director-General of Civil Aviation indicated it as "the military be-all and end-all of aviation." The present complete stoppage of airship work and the unsympathetic attitude of the Air Ministry add further arguments in the same sense. Major Scott's paper on airships finished with an expression of opinion that commercial airships were immediately possible as technical devices, and support was given to this view in the discussion. Another instance of Air Force dominance is furnished by the experiments on a helicopter, mentioned by Lord Gorell and Gen. Bagnall Wild; it appears to be regarded by certain Air Force officers as important and a subject for immediate experiment and research; technical experts and men of science regard expenditure of money on the helicopter as waste owing to the lack of promise of success for very many years to come. The Brennan helicopter at Farnborough is being built in secrecy, and, so far as can be gathered, the Aeronautical Research Committee has not been consulted.

This lack of balance between military wishes and technical possibilities gave point to Col. M. O'Gorman's reference to the need for more scientific knowledge in high quarters at the Air Ministry. He pointed out that fighting now depends on technical complications beyond the understanding of military commanders, and that dependence on their opinions alone will necessarily lead to an unbalanced policy. The need for such remarks was shown by Lord Gorell when he said: "I do not speak in the least degree as a technical expert; probably in the position which I happen to hold it would be a disadvantage to pretend to any degree of technical qualifications." Col. O'Gorman was unable to see why technical and scientific knowledge should be a disqualification in a Minister.

During the discussion on civil transport much reference was made to the need for research, but in the afternoon the theme was research and yet more research. A deep impression on the conference was produced by Sir Richard Glazebrook's references to R38. Lord Gorell's paper contains the passage: "Since the decision of the Dominion Premiers was taken, the conquest of the air has suffered one of the greatest disasters of its history in the terrible accident to R38. It ought to be decisively said that the disaster has not affected, and will not affect, the belief in the future of airships. We are not so faint-hearted a race as to allow ourselves to be deterred even by such an event; *it is the toll that Nature inevitably exacts* from those who seek to probe her secrets—and it has been paid."

Sir Richard Glazebrook asked: "Was the loss of the airship R38, with its crew of officers, technicians, and men, necessary? Was it one of those dreadful and seemingly inevitable incidents in the evolution of a new craft?" and answered his questions by saying that "knowledge existed from experiments in the air tunnels which would have enabled the collapse of the ship to be foretold." The knowledge had not been applied because of a gap between model and full-scale experiments; attempts by the designers and the Aero-

nautical Research Committee to obtain facilities for full-scale experiment on R31, R32, and R33 had failed. He urged as a partial atonement for the sacrifice of the lives of brave men that the remnants of the airship fleet should be devoted to correcting, by full-scale experiments, the knowledge given by model experiments.

The situation with regard to aeroplanes was also said to be unsatisfactory. Prof. L. Bairstow pointed to the prevalence of accidents in aviation, the risks of flying being so great that life insurance companies are not prepared to cover them in a standard policy. This abnormal rate was attributed in part to a number of defects not needing more knowledge for their remedy. The failure of rubber joints in petrol pipes and the breakage of ignition cables were given as instances of easily remediable defects. The danger of such imperfections comes from the necessity for landing at once, when the engine ceases to turn, in country which is often unsuitable. So soon as an aeroplane can take the air it leaves the designer for the user, and its minor defects have not then developed. New design might be encouraged by placing responsibility for such matters on the designer, and not on an Air Ministry staff.

Other causes of failure in flight were said to need more knowledge before they could be removed. All aeroplanes are tricky at low speeds, and it does not accord wholly with fact to attribute an accident to "bad piloting causing the aeroplane to lose flying speed near the ground." Important research work is here called for, the conduct of which may be hindered by an unsuitable organisation as much as by lack of funds. It is reported that the Secretary of State for Air has the matter of the reorganisation of the Air Ministry under review, and has afforded the council of the Royal Aeronautical Society an opportunity for expressing the scientific and technical view of essential requirements for the carrying on of research. It is encouraging to note that Lord Gorell told the Air Conference that "success in the air, whether Service or civil, must depend primarily upon constant scientific research," and that the report of the Geddes Economy Committee, whilst asking for a reduction on the vote for experiment and research, accepts that view.

If research and care in design can reduce the accidents now occurring to one-third of their present amount—a very moderate estimate of early possibilities—the saving of money on flying risks, replacement of aircraft, etc., will very greatly exceed the cost incurred. The position is unusual in the fact that the effects of research on the final product are so clearly seen; such a state is largely due to the infancy of the science, but an important additional element arises from the unparalleled degree of freedom of the motion of aircraft as compared with that of other vehicles.

The Grain of the Photographic Plate.

THE unit of the photographic plate is the single grain of silver salt as it exists in the sensitive film. It is natural, therefore, that after many years and much labour had been devoted to the properties of sensitive films as films, attention should be turned to the unit. A great deal of work has already been done in this direction, but many problems, some of which seem to be of an elementary character, remain to be solved.

On Tuesday, February 14, Prof. The Svedberg, of Upsala, communicated to the Royal Photographic Society two papers containing important results that he has obtained. It is customary in such investigations to dilute the emulsion and so produce a film that contains only a single layer of grains. The characters of the grains are registered by photomicrography, using apochromatic objectives of the maximum practical aperture. As the photography of the grains before treatment must not affect their sensitiveness, Prof. Svedberg used a very deep red light and Ilford special rapid panchromatic plates. After exposure and development the plate may be photographed again, then either the metallic silver produced or the unaffected grains may be dissolved away, as desired, to facilitate the examination of the remainder.

Evidence in favour of the view that the halide grain is either wholly reducible (developable) or not reducible at all is accumulating, and this Prof. Svedberg finds definitely to be the case. By dissolving away the silver grains nothing whatever was left of them, except to the extent of about 1 per cent. of the thousand or so grains observed, which showed traces of incomplete reduction (development).

This independency of the grains is further proved by the unchanged appearance of the undeveloped grains and their unchanged sizes as measured. This holds even when the film is partly solarised by a strong light, when the grains are separated by only 1μ, and whether ferrous oxalate or metol-hydroquinone developer is employed. The author intends to try other conditions to see if, as appears to be the case, these results are general, and that feeding of the reduced silver grains at the expense of the undevelopable grains does not, in fact, take place.

In Prof. Svedberg's second communication he suggests that the larger and the smaller grains in one and the same emulsion are equally sensitive and "are built up of the same kind of light-sensitive material—just as if they were fragments of different sizes from one homogeneous silver bromide crystal." He assumes that by exposure (light action) "developable centres" are produced, and shows experimentally that the distribution of these "centres" takes place according to the laws of chance, so that there is no need to assume a superior sensitiveness of those grains that are made developable. The author is to be congratulated on using the term "centre," which expresses all that is known and is non-committal, rather than "nucleus." Nuclei have been shown to serve, but the crystallisation of sugar on strings is not evidence of the presence of strings wherever sugar crystallises. This by the way.

The present writer in 1911 (Journ. Roy. Phot. Soc., p. 159) showed that by stopping development at a very early stage it was possible to get particles of silver too small to be visible microscopically. They were shown to be present by the colour imparted to the film, and were further demonstrated and measured by adding mercury to them in known and progressive proportions and measuring the enlarged particles. Prof. Svedberg by stopping development at a little later stage gets particles that are just definitely visible microscopically, and shows photographically the relation of these to the original grains of silver haloid. He thus demonstrates that "centres of development" are produced by exposure. A single developable grain may contain one or more (so far up to four) of these "centres." He treats also of other matters, such as the effect of Röntgen rays when used instead of ordinary light.

C. J.

Building Materials and Heat Insulators.

THE Department of Scientific and Industrial Research has issued two special reports on floors and thin walls, the result of work undertaken by an *ad hoc* Building Materials Research Committee appointed to investigate new materials and constructional methods in connection with housing schemes (H.M. Stationery Office, 1*s*. 3*d*. net and 6*d*. net respectively). Some eight types of floors were dealt with, comprising hollow tiles, brick and tile, reinforced concrete, ash concrete, and ordinary wood joists. Suitable sections or units of these floors were erected and tested for carrying capacity to destruction. The results are summarised in tabular form, showing the weight of the floor, load carried, deflection, breaking load, age on testing, elastic limit, and so on. These results are also plotted diagrammatically, and drawings are given showing the construction of each floor to scale. The ash concrete proved weak, and the ordinary joisted floor, though possessing obvious disadvantages from some aspects, appeared to hold its own in the matter of strength. The experiments on thin walls included the testing of brick and concrete blocks and slabs and coke-breeze materials. Consistent results showed that the crushing strength of the walls varied from 67 to 83 per cent. of that of cubes of the materials respectively employed. Lengths of wall of 14 in. and 3 ft. 6 in. and 2⅝ in. to 4½ in. thick were dealt with. These strips were 8 ft. 6 in. high, and the horizontal pull necessary to make the wider strips collapse was measured. The materials built in lime mortar on account of early failure under test give rise to criticism of lime as a binding agent, but surely the behaviour of walls so built after only twenty-four days cannot be fairly compared with that of similar walls built in cement which sets in a day or two. Lime was used in all our national buildings until comparatively recent years; it is cheaper in actual cost and labour than cement, and its wider use merits revival. These experiments are valuable and interesting; it has to be remembered, however, that the country builder usually fears new methods, and is apt to put unduly high prices on unknown forms of construction.

The fifth special report of the Food Investigation Board, issued by the Department of Scientific and Industrial Research, consists of an account of experiments on heat insulators suitable for use in cold stores. The work has been carried out at the National Physical Laboratory by Dr. Ezer Griffiths, and so far has been devoted to the determination of the thermal conductivity of a number of materials adapted to low-temperature insulation. In the experiments a warm surface, consisting of a metal plate electrically heated, was maintained at a steady temperature and placed opposite to a similar plate cooled by brine circulation, the material under test filling the space between the two plates. Special precautions were taken to eliminate errors arising from edge effects in the warm plate and air convection in the material, and when a steady temperature had been attained in both plates the heat passing through the lagging was deduced by measuring the watts furnished to the warm plate. The results obtained show that the conductivity in C.G.S. units for slab cork is 0·00011; granulated cork, 0·00011 to 0·00019; slag wool, 0·000102; and dry charcoal, 0·000122. A number of other substances giving higher values were also tested, and mention is made of a cellular form of rubber which from preliminary tests appears to be superior to any other material examined, its conductivity being about 0·000085. As an appendix to the report, a description is given of the apparatus devised by Dr. Griffiths for determining the specific heats of the materials under notice. Although other factors, such as moisture absorption and liability to organic growths, have to be taken into account in choosing a lagging for a cold store, the figures obtained by Dr. Griffiths should prove of much practical value to those engaged in the refrigerating industry.

Industrial Fatigue.

THE Industrial Fatigue Research Board, which has recently been reconstructed as an advisory body under the Medical Research Council, is to be congratulated upon the publication of two highly valuable and most interesting reports. These are doubtless a legacy to it from the older Board the wider sphere and greater liberty of action of which were recently brought to an end by the Treasury under the pretext of economy. They are published by H.M. Stationery Office at 1*s*. and 2*s*. respectively, Report No. 12 being on vocational guidance and Report No. 15 on motion study in metal polishing. The former of these reports, written by Mr. B. Muscio (who has since accepted a professorship in the University of Sydney), gives a detailed review of the literature on vocational selection. The list of nearly sixty books and papers at the end of the report indicates the diligence which the author has brought to bear on his task. The report is divided into three sections: (1) introductory, (2) summary of special investigations, and (3) future investigations. The second section, filling forty-two of the fifty-seven pages, contains a most able and critical account of the psychological tests that have been applied to clerical, engineering, and metallurgical occupations, music, printing, salesmanship, telegraphy, telephone exchange work, transport work, war experiments, etc. Prof. Muscio indicates in his last section the wide field which is now open for future investigations conducted on a broader scale and on a more systematic basis than hitherto.

Not less valuable is the Board's Report No. 15 on motion study in metal polishing by Messrs. E. Farmer and R. S. Brooke. These investigators prove very conclusively what an enormous wastage of effort now occurs in the "buffing" (spoon and fork polishing) trade owing to the lack of a systematic course of training for newly entering workers. They indicate the principles on which such a course should be based, and give data derived from the actual application of those principles, which "prove conclusively that a beginner, given adequate training, can become an expert dollier within a very few days, but left to herself, without proper instruction, she probably will never become highly skilled, and will continue all her life to waste her energy in unnecessary and unproductive movements." The influence of fatigue was ingeniously studied by means of a recording wattmeter which they applied to the machines employed for removing scratches and other imperfections from spoons and forks. It was found that as towards the end of the day the girls' output diminished and their

fatigue increased, they tended to give more vigorous and more numerous strokes, to pause longer between each stroke, and to take a longer time over each stroke. In other words, Messrs. Farmer and Brooke prove that the tired "rougher" is "not only working slower than when she is fresh. but is also expending her energy extravagantly."

University and Educational Intelligence.

London.—The Franks research studentship in archæology, value 100*l.* for one year, is offered. Applications must reach the Academic Registrar, the University of London, South Kensington, S.W.7, by, at latest, March 2.

Sheffield.—The council of the University has made the following appointments:—Mr. Douglas Hay to be professor of mining; Mr. A. J. Saxton, assistant lecturer in physics; Mr. L. W. Cole, assistant lecturer and demonstrator in botany; Mr. H. W. Southgate, lecturer in pharmacology; Dr. E. F. Finch and Mr. V. Townrow, assistant curators of the Pathological Museum; and Dr. A. G. Yates, demonstrator in medical pathology.

Last year the Civic Education League organised a very interesting Easter visit to Belgium for the purpose of civic study. This year a similar visit to Holland is being arranged. Anyone interested in civic studies may join the party, and early application to Miss Margaret Tatton, secretary, Civic Education League, Leplay House, 65 Belgrave Road, S.W.1, should be made. Members of the party will have special facilities for first-hand contact with the work and *personnel* of the chief social and economic institutions of the country.

The annual prize distribution at the Sir John Cass Technical Institute, Aldgate, E.C.3, was held on Wednesday, February 8, when the prizes were distributed by Prof. William Rothenstein, principal of the Royal College of Art. The chairman of the governing body, the Rev. J. F. Marr, in giving a summary of the work of the institute during the past session, stated that the increase in the number of students had been more than maintained, and that the capacity of the institute, especially in the science departments, had been taxed to the utmost. Twenty students had been engaged in research work during the session, and the total number of investigations published from the institute had now reached 115. The Department of Petroleum Technology, which was initiated at the commencement of the present session, is one of the institute's most important developments, and there were already 150 students in attendance. Representatives of the industry have acted as a consultative committee to advise the governors in respect to the courses of study which have been provided, and the chief oil companies of the London area have given generous support towards the equipment and maintenance of the department. In the course of an address on "Education and Industry" Prof. Rothenstein said he regarded every kind of education as something in the nature of a pursuit after truth. Whereas there was much lip-homage to science and art and the crafts by our merchant princes and captains of industry, these employers did not have the same faith in them as their employees. Commercial men in past civilisations somehow knew how to ask for the best, but that was not true of our own civilisation. What we required was a standard of commerce which knew how to utilise what was best in the arts and sciences, for he refused to believe that people, in general, did not value that which was good and beautiful in production.

Calendar of Industrial Pioneers.

February 16, 1890. William Jarvis McAlpine died.—Trained under Jervis, the chief engineer of the Delaware and Hudson Canal, McAlpine became State Engineer for New York, and was also State Railroad Commissioner. At the request of the Austro-Hungarian Government he prepared plans for the improvement of the Danube. He was the first American to become a member of the Institution of Civil Engineers, and in 1886 was president of the sister institution in the United States.

February 18, 1888. Thomas Turner Tate died.—In conjunction with Sir William Fairbairn, Tate was the author of memoirs on the vapour tension of superheated steam and on the strength of materials in relation to the construction of iron ships, and was the inventor of the double piston air-pump. For some years he was mathematical master at Battersea Training College, and was known for his educational works.

February 19, 1816. Jean Pierre François Guillot Duhamel died.—An early student at the Ecole des Ponts et Chaussées, Duhamel accompanied Gabriel Jars in his extended industrial tour throughout Europe, and on his return to France did much to improve the manufacture of steel. He afterwards became Government Inspector of Forges and Furnaces, a professor of metallurgy at the Ecole des Mines, and a member of the Paris Academy of Sciences.

February 20, 1825. Joseph Marie François Cachin died.—One of the most distinguished French civil engineers of his day, Cachin was intimately connected with the improvements of the harbour of Cherbourg, and in 1820 published his "Mémoire sur la digue de Cherbourg comparée au breakwater, ou jetée, de Plymouth."

February 20, 1826. Matthew Murray died.—With Fenton and Wood, Murray founded a mechanical engineering works at Leeds which became one of the rivals of Boulton and Watt. The firm built flax-making machinery and constructed some of the earliest Blenkinsop locomotives, and Murray is generally credited with the invention of the short D-slide valve for steam engines.

February 20, 1913. Sir William Arrol died.—The builder of many famous bridges, Arrol between 1882 and 1887 reconstructed the viaduct over the Firth of Tay, and between 1883 and 1890 built the Forth Bridge. This bridge, designed by Fowler and Baker, has always been regarded as one of the greatest engineering structures in the world. With a total length of 8295 ft., of which the three cantilevers account for 5349 ft., the bridge contains 51,000 tons of steel, while the towers rise to a height of 360 ft. and the line is carried 150 ft. above the water at high tide. Arrol was knighted at the opening of the bridge by Edward VII.

February 21, 1888. George Henry Corliss died.—The greatest steam-engine builder of America, Corliss about 1848 entered into partnership with Nightingale at Providence, Rhode Island. Adopting the trip gear of Sickells, he brought out the Corliss form of steam engine, which on account of its improved economy and regular turning movement became known all over the world.

February 21, 1912. Osborne Reynolds died.—For nearly forty years professor of engineering at Owens College, Manchester, Reynolds made many investigations of importance to engineers and shipbuilders, such as those on screw propulsion, the flow of liquids, the condensation of steam, the transmission of heat, and lubrication. He was the inventor of the compound turbine.

E. C. S.

Societies and Academies.

London.

Royal Society, February 9.—Sir Charles Sherrington, president, in the chair.—Sir J. Alfred **Ewing**: The atomic process in ferromagnetic induction. In the old model representing the process of ferromagnetic induction, the Weber elements or ultimate magnetic particles were represented by pivoted magnets the alignment of which, in the absence of an impressed field, was determined by the forces which they exerted on one another. The model is unsatisfactory; when the range of stable deflection is sufficiently narrow the stability becomes too great. In the new model the idea of magnetic control is retained, with a Weber element in each atom, but the controlling force is supposed to be exerted between the electrons of the atom itself, namely, between the shell, which is held more or less fixed by its relation to neighbouring atoms, and an inner electron system which constitutes the Weber magnet. The control depends on the difference between two nearly equal opposing forces; this characteristic permits the model to combine a sufficiently weak control with a narrow range of stable deflection. In one model considered the structure is based on the grouping of electrons suggested by Hull in connection with his X-ray analysis of iron crystals; in another the electron orbits are assumed to have the nucleus of the atom at their common focus.—J. W. **Nicholson**: Problems relating to a thin plane annulus. Only first approximations of solutions of problems relating to a thin plane annulus appear to have been used hitherto. Higher approximations have now been obtained, and the actual difference of radii of the circles bounding the annulus is of comparatively small significance in such magnitudes as the electrical capacity of the annulus. The whole investigation is carried to the second order of significance by treating the annulus as a special case of the elliptic anchor ring, but it can be extended. The convergence of such approximate solutions appears to be analogous to the degree of convergence found by Lord Rayleigh in certain solutions of problems of vibration of discs in which eccentricity is taken into account.—T. H. **Havelock**: The effect of shallow water on wave resistance. An analysis of the wave resistance of a surface pressure symmetrical round a point and moving over the surface of deep water is extended so as to include the effect of finite depth of water. The wave resistance is given by a definite integral which is evaluated by numerical and graphical methods. The cases intermediate between deep water and shallow water show the effect of limited depth in lowering the principal wave-making velocity and in increasing the effects near the velocity of the wave of translation.—R. H. **Fowler** and C. N. H. **Lock**: The aerodynamics of a spinning shell. Pt. 2. Of the shells fired from two guns giving different degrees of axial spin, those fired from the gun giving the more rapid spin were all stable, most of the others being unstable, as shown by the larger yaw developed. For yaws up to 35° a solution of the equations of motion can still be obtained in elliptic functions which proves adequately general.—F. B. **Pidduck**: The kinetic theory of a special type of rigid molecule. The methods of Chapman and Enskog in the kinetic theory of gases are applied, with modifications, to a type of rigid molecule to discover how viscosity is affected by energy of rotation, and the relative transport of translational and rotational energy in thermal conduction. The molecule model is considered as a sphere which grips at each collision and rebounds without dissipation of energy. The results support Eucken's views on Chapman's constant f for polyatomic gases.—J. E. **Jones**: The velocity distribution function and the stresses in a non-uniform rarefied monatomic gas. From Boltzmann's equation a symbolic solution of the velocity distribution function is obtained; from the new equation, by an analogous treatment, the exact nature of the function is deduced. The rate of change of molecular properties by collision follows more directly from this equation than from that used by Maxwell. To illustrate the present method, the results obtained by Chapman and Enskog for a normal gas are calculated anew. The treatment is extended to a rarefied gas and expressions are obtained for stresses due to non-uniformity of temperature. The special Maxwellian model is considered and Maxwell's result confirmed. The molecular model of a gas consisting of rigid elastic spheres is then considered in detail. The numerical coefficient in this case differs by about 20 per cent. from that of the Maxwellian gas.—H. **Bateman**: The numerical solution of integral equations. An approximate solution of an integral equation of Fredholm's type is obtained by using an approximate representation of the kernel by means of a double series of known functions. One such series is written down immediately in the form of a determinant, and the solution of the integral equation with the approximate kernel is also written in the form of a determinant. The kernel of the integral equation can also be represented approximately by a polynomial.—W. B. **Hardy** and Ida **Doubleday**: Boundary lubrication: The paraffin series. The lubricating properties of normal paraffins and their related acids and alcohols have been studied under the conditions of boundary friction. Amonton's law, that friction varies as the loads and is independent of the areas, is rigorously true for the same bearing surfaces and lubricants. The friction is independent of the quantity of lubricant present. It is a linear function of molecular weight, so that $\mu = \text{friction} \div \text{load} = a - b\text{M}$, where M is molecular weight and b a pure function of chemical constitution; the slope of the curve is greatest for acids, and sensibly the same for paraffins and alcohols. Changing from one acid to another shifts the curves parallel to themselves, so for the same chemical series a is a pure function of the nature of the solid faces. Each solid face contributes one-half of a, and each molecule of lubricant furnishes a constant quantity to the total effect independently of the total number of molecules present.

Aristotelian Society, January 16.—Dr. F. C. S. Schiller, president, in the chair.—H. J. **Paton**: Plato's theory of εἰκασία. In Plato's account of the Line and the Cave in the "Republic" he distinguishes two sub-divisions of opinion (εἰκασία, or intuition, and πίστις, or belief) and two sub-divisions of knowledge (διάνοια, or mathematical reasoning, and νόησις, or philosophical reasoning). This must be understood as implying a difference of objects in each of the four sub-divisions, just as the objects of opinion and knowledge are different—the changing individuals as opposed to the unchanging universals. The parallelism or analogy between the objects of the two main divisions and those of the sub-divisions is meant to be taken seriously throughout. In particular, the objects of the εἰκασία, or intuition, are the many appearances whether given in what we call sense or memory or imagination, from which we pass to the objects of πίστις, or belief—the solid bodies of the ordinary consciousness and of science, things relatively permanent and relatively intelligible in comparison with their many appearances, although changing and unintelligible in comparison with the really permanent and really intelligible εἴδη, or universals. It is a complete error to

regard εἰκασία and its objects as of no metaphysical importance, and an understanding of the nature of this section is necessary if we are to grasp Plato's general theory of knowledge. Even Plato's theory that art must be classified under this first cognitive activity of the spirit is in its essence sound, in spite of the fact that some of the conclusions which he derived from it were mistaken.

Association of Economic Biologists, January 27.—Sir David Prain, president, in the chair.—E. P. **Stebbing**: The importance of scientific research in forestry and its position in the Empire. In India a research institute was formed at Dehra Dun in 1906, and the fully equipped building completed by 1914. It has now become necessary to decentralise research work to some extent, and a fine institute is already in existence at Coimbatore, in Madras. Elsewhere in the Empire, with the exception of Canada and at home, the forest services are only in the initial stages of the introduction of the work. A start should be made in the branches of forest botany and forest economics. At home a well-equipped research institute is most urgently needed which would work in collaboration with the educational centres the staffs of which have time available to devote to research work. Until such a research institute is established full use should be made of centres the equipment of which is adequate for carrying on research on the lines which the Forestry Commission may suggest.

Physical Society, January 27.—Sir William Bragg in the chair.—T. H. **Littlewood**: The diffusion of solutions. An optical method is described for finding the concentration at various depths in a diffusing solution. The solution is contained in a closed vessel, the top and one side of which are of glass. On the glass side is a vertical scale. This vessel is immersed in water containing a mirror which can be rotated, and the position of which is read on a graduated scale by a telescope which carries a horizontal wire illuminated by sodium light. The mirror is adjusted so that the image of the wire, after twice passing through the liquid, is seen on the cross wires of the telescope, and the reading on the vertical scale is also observed. The concentration can be determined at different depths with an accuracy of about 0·05 gr. per litre. From a series of measurements at different times the coefficient of diffusion can be calculated. Sufficient data can be obtained in less than a day.—H. R. **Nettleton**: A special apparatus for the measurement at various temperatures of the Thomson effect. The short wire under test (S.W.G. 18) passes through electrical heaters which may quickly be brought to, and maintained at, steady temperatures differing by some 50° C. over the range 20° C. to 250° C. A short coil of the finest double silk-covered copper wire (S.W.G. 44) acts as the Thomson-Joule heat detector.—J. J. **Manley**: A defect in the Sprengel pump: its causes and a remedy. A plan whereby the limitations and irregularities of the Sprengel pump resulting from the presence of air skins upon the interior surfaces may be made negligible is described. The efficiency of the new pump is superior to that of the older forms, and appears to be constant.

DUBLIN.

Royal Dublin Society, January 24.—Mr. G. Fletcher in the chair.—H. H. **Poole**: Some notes on the distribution of activity in radium therapy under different conditions of screening. Tests were made of the screening effect of various materials on the complex radiation emitted from a thin-walled emanation tube. From these the activity at various depths in the tissues were calculated for several arrangements of surface applications and for emanation needles.

EDINBURGH.

Royal Society, January 9.—Prof. F. O. Bower, president, in the chair.—R. A. **Houstoun**: A new method of investigating colour-blindness, with a description of twenty-three cases. The method was based on Maxwell's colour diagram, and consisted in testing the power of discriminating between contiguous tints of colour as the tint was varied continuously by stages from, say, red to green by an increasing admixture of green with red. The results for each observer were represented by contour lines on the triangular colour diagram. The ability of the observer to discriminate between any pair of colours could be seen from his diagram at a glance, irrespective of the terminology of any particular theory. More than 1400 students of Glasgow University had been tested during the last four years. All the cases of colour-blindness investigated seemed to be trichromatic in Maxwell's sense, not dichromatic as stated in text-books. Also, two observers who confused ordinary greens and reds were found, on the whole, to have quite as good a power of discriminating colour as the normal. Their trouble was apparently due to their colour-vision being extra sensitive to changes of wave-length in the green part of the spectrum, and not sensitive enough to changes of wave-length in the yellow.—W. Gordon **Brown**: The Faraday-tube theory of electromagnetism and other notes. The author met his death in France in 1916 at the age of twenty-one, and these papers were written in 1915–16 while he was convalescing after his Gallipoli experiences. He had just finished school in 1914, and he joined the Forces immediately war was declared. In the principal paper he established, on the assumptions of moving tubes of electric force, the equations of the electromagnetic field, and in a shorter quaternion investigation he worked out certain results on the hypothesis that the mass operator which changes velocity to momentum is a linear vector function. A few months before his death he was treating the problem of the tubes of force along the lines of the four-dimensional analysis developed by Minkowski, and communicated his results in a letter written to Prof. Whittaker.—T. Bedford **Franklin**: Some simple experiments on the colloidal content of soils. The mechanical analysis of a soil is no guarantee of its physical behaviour, for although the soil colloids are mainly contained in the finer fractions, yet the colloidal content of these fractions, as shown by analysis, can vary over a very large range. The paper described simple experiments for estimating the colloidal content. Thus a soil is probably highly colloidal if (1) it takes up a high percentage of water on the dry weight of the soil before reaching "maximum plasticity"; (2) its rate of evaporation declines slowly with diminishing water content; (3) it freezes well below 0° C.; (4) it takes up, after drying or freezing, much less water before reaching "maximum plasticity" than in its natural condition; and (5) it absorbs and retains for a long time farmyard or artificial manure.

PARIS.

Academy of Sciences, January 30.—M. Emile Bertin in the chair.—C. **Lallemand**: The comparative advantages of the hexagonal abacus and the abacus with aligned points.—C. **Moureu** and C. **Dufraisse**: Auto-oxidation. The anti-oxidisers.—G. **Gouy**: The pressure in magnetised or polarised fluids.—M. Maurice d'Ocagne was elected a free academician in succession to the late M. J. Carpentier.—T. **Varapoulos**: A theorem of M. Montel.—A. **Angelesco**: The zeros of certain functions.—A. **Cahen**: Differential equations of the first order with fixed critical points.—M. **Auric**: The development as a continued fraction of algebraical numbers.—R. **Jacques**: Surfaces such that the axes

of the osculating circles with one family of lines of curvature belong to a linear complex.—E. **Belot**: The periodicity and the movement of the sun-spots in latitude explained by the pulsation of the nucleus. Assuming that the dense nucleus of the sun (barosphere) has a pulsation with a period of eleven years, the consequences are worked out and give an explanation of the currents from north to south in the perisphere, observed, but not explained, by Oppolzer; the movement of the spots towards the equator (Spörer); and the displacement of the latitude of the maximum number of spots, which, according to Faye, should be in latitude 37° 38′, and is, in fact, about 17°.—H. **Chaumay**: The measurement of insulation resistance by the method of accumulation.—M. **Dufour**: The relation between aberration and astigmatism for a point situated on the axis of a centred optical system.—J. **Rey**: Range obtained by a beacon light of great power fitted with metallic reflectors. This light is installed on the Island of Galiton, north-west of Bizerta, and is 165 metres above sea-level. The calculated range was 30 miles. It can be frequently seen from Tabarka, 33 miles away, and in clear weather at Ras-Enhelah (41 miles).—H. **Weiss** and P. **Henry**: The influence of temperature on the velocity of interpenetration of solids. The alloy studied was silver containing 14 per cent. of antimony; the results are given in a series of curves.—E. **Darmois**: Two new molybdo-malates of ammonium. Gernez has shown that the rotatory power of malic acid undergoes considerable variation when increasing quantities of ammonium molybdate are added to the solution. From a study of the rotation of solutions of malic acid and ammonium molybdate two definite compounds, $MoO_3 \cdot 2C_4H_6O_5 \cdot 2NH_3$ and $MoO_3 \cdot 2C_4H_6O_5 \cdot 4NH_3$, were indicated, the first being the more stable. The isolation of these two compounds is described.—MM. **Seyewetz** and **Vignat**: The action of sodium sulphite on nitrobenzene. Nitrobenzene is reduced by a boiling 10 per cent. solution of sodium sulphite. The main product of the reaction is *p*-amidophenol sulphonic acid.—C. **Jacob**: The structure of North Annam to the south of Thanh Hoa.—F. **Blanchet** and E. **Chagny**: New observations on the dislocation of the Montagne de la Bastille, near Grenoble.—C. **Corroy**: Some Neocomian fishes of the Haute-Marne and the Meuse.—L. **Joleaud**: The area of dispersion of Dyrosaurus, a fossil crocodile from North-West Africa.—A. **Boutaric**: Observations carried out on Mont Blanc. Details of polarimetric and actinometric observations made hourly, between 7 a.m. and 6 p.m., at the Vallot Observatory between July 31 and August 7, 1921.—L. **Gentil**: The climatology of Morocco. In the absence of extended meteorological observations the study of the vegetation furnishes a valuable guide to climatic conditions. The rainfall chart in eastern Morocco of M. Augustin Bernard cannot be accepted without reserve.—P. **Schereschewsky** and P. **Wehrlé**: The signification of cirrus clouds in the prediction of weather. Cirrus clouds have often been considered as indicating the approach of rain; the authors show that the cloud system must be studied as a whole. Cirrus clouds are always indications of the proximity of a cloud system, but it does not necessarily follow that the system will pass over the observing station. It is necessary for the meteorologist to be able to determine the position of the cloud system in relation to the observing station, its direction of motion, and its velocity of displacement, before utilising cirrus clouds as a means of weather prediction.—Mlle. C. **Veil**: The relation between the chlorine index and the nitrogen content of plant-soil. The chlorine index is given by the amount of active chlorine absorbed by the soil from a solution of sodium hypochlorite. It is shown that there is a relation between this figure and the amount of nitrogen in the soil.—P. **Dangeard**: The origin of the vacuoles at the expense of the aleurone grains during the germination of the Graminaceæ.—W. **Kopaczewski**: Surface tension and narcosis. As a general rule narcotics and anæsthetics lower the surface tension of the blood-serum, and there is a parallelism between the amount of lowering and the narcotic power. There are exceptions, morphine being the most notable.—R. **Jeannel**: The variation of the copulating organs in the Coleoptera.—L. **Léger** and E. **Hesse**: Microsporidia resembling bacteria in form, and an attempt at a systematic classification of the group.—Mme. Anna **Drzewina** and G. **Bohn**: The phenomena of auto-destruction and auto-agglutination in the Convoluta.—M. **Aron**: The morphological signification of the endocrinian glandular tissue of the testicle in the crested triton.

SYDNEY.

Royal Society of New South Wales, December 7, 1921.—Mr. E. C. Andrews, president, in the chair.—C. A. **Sussmilch**: The geology of the Gloucester district. The strata of the Gloucester district (N.S.W.) belong to the Devonian Carboniferous and Permo-Carboniferous periods. During the Devonian period a thick series of shales, radiolarian cherts, and tuffs was laid down on a sea-floor. Submarine volcanic activity and important crustal movements took place during and at the close of this period. At the beginning of the Carboniferous period (Burindi stage) the region was under relatively shallow water. Long-continued slow subsidences allowed of the depositing of a very thick series of shales, limestones, conglomerates, and tuffs, aggregating 12,000 ft. in thickness. Later an uplift took place, and during the Kutting stage which followed volcanic activity was the most striking feature. The land flora (Rhæopteris, etc.) at this time consisted largely of ferns. Towards the close of the Permo-Carboniferous period a subsidence began which led to the formation of a large shallow lake. At intervals conditions became stable, the lake became a swamp covered by dense vegetation (the Glossopteris flora), and during these periods coal-seams were formed. There are at least eight coal-seams in the Gloucester district, the largest of which is 32 ft. thick. At the close of the Permo-Carboniferous period the region was subjected to intense folding forces, forming big mountain ranges. Since then there have been a succession of uplifts, the last of which took place at the end of the Tertiary period, and produced a tableland 2000 ft. in altitude.—O. U. **Vonwiller** The conduction of electricity in molybdenite.—G. J. **Burrows** and E. E. **Turner**: The preparation of certain ferrioxalates.—J. H. **Maiden**: An additional blue-leaf stringybark. A blue-leaf stringybark already described is *E. laevopinea*, R. T. Baker; the new species is more closely allied to *E. Blaxlandi*, Maiden and Cambage, and *E. capitellata*, Sm. It is a large tree, with sessile heads of small compressed spheroid fruits, which is confined, apparently, to New South Wales.—W. L. **Waterhouse**: The production in Australia of the æcidial stage of *Puccinia graminis*, Pers. Inoculations on barberry shoots with rust on wheat grown at Glen Innes, N.S.W., gave numerous infections from which æcidiospores were used to reinfect wheat.—A. R. **Penfold**: The essential oil obtained of the leaves of *Doryphora sassafras*, Endlicher. The yield of oil from leaves of the New South Wales sassafras tree was about 1 per cent., and it possessed the fragrance characteristic of sassafras oils. The principal constituents identified are safrol, camphor, pinene, sesquiterpenes, eugenol, and alcoholic bodies.

Official Publications Received.

Office Scientifique et Technique des Pêches Maritimes. Notes et Mémoires, No. 12: La Coopération de la Navigation Aérienne aux Pêches Maritimes. Extrait des Rapports sur les sorties en Dirigeable et en Avion effectués les 25 Août et 1er Septembre, 1921. Par H. Heldt. Pp. 8. 3 francs. Notes et Mémoires, No. 13: Recherches sur la Variation de l'Iode. Chez les principales Laminaires de la Côte bretonne. Par M. P. Freundler and Mlle. Y. Menager. Pp. 24. 4 francs. (Paris: Ed. Blondel la Rougery.)

Annual Report of the Department of Fisheries, Bengal and Bihar and Orissa, for the Year ending 31st March, 1921. Pp. vi+10+2 (Calcutta: Bengal Fishery Department.) 5 annas.

Ministry of Interior: Department of Refugees. Publication No. 6: The League of Nations and the Greeks and Armenians in Turkey. Pp. 62. (Constantinople.)

Imperial Department of Agriculture for the West Indies. Sugar-Cane Experiments in the Leeward Islands. Report on Experiments conducted in Antigua, St. Kitts-Nevis, and Montserrat in the Season 1919-20. Part 1: Experiments with Varieties of Sugar-Cane. Part 2: Manurial Experiments with Sugar-Cane. Pp. iv +57. (Barbados: Department of Agriculture.) 1s.

Memoirs of the Department of Agriculture, Trinidad and Tobago. No. 2: A Catalogue of the Trinidad Lepidoptera Rhopalocera (Butterflies). By W. J. Kaye. Pp. 163. (Trinidad.) 2s. 6d.

The Carnegie Trust for the Universities of Scotland. Twentieth Annual Report (for the Year 1920-21) submitted by the Executive Committee to the Trustees on 8th February, 1922. Pp. iv+83. (Edinburgh: The Carnegie Trust, Merchants' Hall.)

Comité International des Poids et Mesures. Procès-Verbaux de Séances. Deuxième série, Tome 9, Session de 1921. Pp. viii+110. (Paris: Gauthier-Villars et Cie.)

Madras Fisheries Department. Bulletin No. 12: Administration Report, 1918-19, and The Outrigger Canoes of Indonesia, by James Hornell: A Statistical Analysis of an Inshore Fishing Experiment at Madras, 1919, by M. Ramaswami Nayudu; Reports on the Fisheries of the Nilgiris, by the late H. C. Wilson: Notes on the Cichlid Fishes of Malabar, by N. P. Panikkar. Pp. iv+166+16 plates. (Madras: Government Press.) 4 rupees.

Diary of Societies.

THURSDAY, FEBRUARY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. G. Perkin: Dyeing: Ancient and Modern (1).

ROYAL SOCIETY, at 4.30.—Prof. L. Hill, D. H. Ash, and J. A. Campbell: The Heating and Cooling of the Body by Local Application of Heat and Cold.—Prof. J. B. Cohen, C. H. Browning, R. Gaunt, and R. Gulbransen: Relationships between Antiseptic Action and Chemical Constitution, with Special Reference to Compounds of the Pyridine, Quinoline, Acridine, and Phenazene Series.—D. T. Harris: Active Hyperæmia. —B. B. Sarkar: The Depressor Nerve of the Rabbit.—Prof. A. Lipschütz, Dr. B. Ottow, C. Wagner, and F. Bormann: The Hypertrophy of the Interstitial Cells in the Testicle of the Guinea Pig under Different Experimental Conditions.

CHINA SOCIETY (at School of Oriental Studies), at 5.—Miss E. G. Kemp: Some Aboriginal Tribes in China.

LINNEAN SOCIETY OF LONDON, at 5.—Prof. R. R. Gates: The Inheritance of Flower Size in Plants.—W. Dallimore: Exhibition of Dwarf Trees, showing Wind Effect on Rocks at Llandudno.—J. L. North: Acclimatisation of the Soja Bean, *Glycine Soja*.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Sqdr.-Ldr. C. F. A. Portal: Methods of Instruction in Aeroplane Flying.

INSTITUTION OF MINING AND METALLURGY (at Geological Society of London), at 5.30.—J. M. Bell: The Occurrence of Silver Ores in South Lorrain, Ontario, Canada.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—F. P. Whitaker: Rotary Converters, with Special Reference to Railway Electrification.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting), at 8.—L. F. Watson: Mechanical Efficiency.

CHEMICAL SOCIETY, at 8.—A. Lapworth: A Theoretical Derivation of the Principle of Induced Alternate Polarities.—W. O. Kermack and R. Robinson: An Explanation of the Property of Induced Polarity of Atoms and an Interpretation of the Theory of Partial Valencies on an Electronic Basis.

SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, W.C.2), at 8.—E. B. Turner: Sex Relationships.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.1), at 8.15.—Major F. W. Cragg: Relapsing Fever in India.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, FEBRUARY 17.

GEOLOGICAL SOCIETY OF LONDON (Anniversary), at 3.—Presidential Address.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof Swale Vincent: A Critical Examination of Current Views on Internal Secretion (Arris and Gale Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—A. T. Wall: Electric Welding applied to Steel Construction, with Special Reference to Ships.

BRITISH ELECTRICAL DEVELOPMENT ASSOCIATION (at Chartered Institute of Patent Agents, Staple Inn Buildings, W.C.2), at 7.30. —H. Harrison: Salesmanship in Relation to Electric Lighting.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—W. J. Leaton: Water Purification for Boiler Feed Purposes.

SOCIÉTÉ INTERNATIONALE DE PHILOLOGIE, SCIENCES ET BEAUX-ARTS (Celtic Section) (at 8 Taviton Street, W.C.1), at 8.—Dr. W. J. E. Scott: The Mines of El Dorado: an Historical Account of the Maritime Trade of Spain with Ireland, 2000 to 700 B.C. (2).

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30. —Dr. G. W. C. Kaye: Radiology and Physics (Mackenzie-Davidson Memorial Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. D. S. M. Watson: History of the Mammalian Ear.

SATURDAY, FEBRUARY 18.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. A. Gardner: Masterpieces of Greek Sculpture (1).

PHYSIOLOGICAL SOCIETY (at School of Medicine for Women, Hunter Street, W.C.1), at 4.—J. S. Haldane: Working Model to Illustrate a Theory of Muscular Contraction.—C. da Fano: Permanent Golgi-Cox Specimens.—W. W. Waller: The Microscopic Appearances of Red Blood Corpuscles in Hypertonic Saline.—W. Cramer: Slides Demonstrating the Functional Activity of the Suprarenal Medulla.—W. D. Halliburton and D. H. de Souza: Secretin by the Portal Route.—J. W. Pickering and J. A. Hewitt: Some Physico-chemical Aspects of Blood Coagulation.—J. A. Hewitt and Dorothy B. Steabben: Note on the Fermentation of Inositol. —M. Bond: (a) Fat Soluble A Content of Bacon Fat; (b) Food Value of Dried Egg-white.—E. E. Hewer: Some Observations on the Results of Suprarenal Inoculations.—M. O. P. Wiltshire: Oxygen Intake of Women during Muscular Work.—W. C. Cullis and M. Ross-Johnson: Periodic Variations in Temperature in Women.—W. C. Cullis: Oxygen Consumption as a Test of Fatigue. —G. V. Anrep and R. K. Cannan: The Blood Sugar Metabolism of the Submaxillary Gland.—A. N. Drury: The Effect of Vagal Stimulation on Intra-auricular Block produced by Cold (Mammalian Auricle).—J. Trevan and E. Boock: Note on the Effect of Section of the Vagus on the Respiratory Centre of the Cat.—H. W. Haggard and Y. Henderson: Hæmorrhage as a Form of Asphyxia.

MONDAY, FEBRUARY 20.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. F. Hetherington and others: Discussion on The Emergency Use of Oil Fuel during the Recent Coal Strike.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—A. J. Davis: The Internal Decoration of Ocean Liners.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.1), at 8.—Prof. H. Wildon Carr, Dr. Dorothy Wrinch, Prof. T. P. Nunn, and Prof. A. N. Whitehead: Discussion on the Idealistic Interpretation of Einstein's Theory.

ROYAL SOCIETY OF ARTS, at 8.—Prof. A. F. C. Pollard: The Mechanical Design of Scientific Instruments (1) (Cantor Lecture).

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—A. F. R. Wollaston: Natural History of South-western Tibet.

TUESDAY, FEBRUARY 21.

INSTITUTION OF ELECTRICAL ENGINEERS, at 3.—Meeting in commemoration of the First Meeting of the Society of Telegraph Engineers on February 28, 1872.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire: Racial Problems in Asia and Australasia (1).

ROYAL SOCIETY FOR THE PROTECTION OF BIRDS (at the Middlesex Guildhall, Westminster, S.W.1), at 3.—Viscount Grey of Fallodon: Address on the Work of the Society.

ROYAL STATISTICAL SOCIETY, at 5.15.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. R. Broom: The Temporal Arches of the Reptilia.—Dr. H. Blegvad: Animal Communities in the Southern North Sea.—Dr. C. F. Sonntag: (1) The Vagus and Sympathetic Nerves of the Edentata. (2) The Vagus and Sympathetic Nerves of *Hyrax capensis*.—C. Tate Regan: The Cichlid Fishes of Lake Victoria.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Discussion on paper by Dr. H. F. Parshall on: Hydro-Electric Installations of the Barcelona Traction, Light and Power Company.—A. C. Walsh and W. F. Stanton: The Improvement of the Port of Valparaiso.

WOMEN'S ENGINEERING SOCIETY (at 26 George Street, W.1), at 6.15. —Mrs. H. Irving: Model Experiments in Aeronautics.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—D. R. Hutchinson: Types of Large Marine Engines.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—G. A. Booth: Natural History Photography.

WEDNESDAY, FEBRUARY 22.

INSTITUTION OF ELECTRICAL ENGINEERS, at 3.30 and 8.30.—Meeting in Commemoration of the First Meeting of the Society of Telegraph Engineers on February 28, 1872.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. C. W. Andrews: Description of a New Plesiosaur from the Wealden Clay of Sussex.—T. Landell-Mills, with Notes on the Petrography by Dr. A. Gilligan, and on the Palæontology by Dr. A. Smith Woodward: The Carboniferous Rocks of the Deer Lake District of Newfoundland.

ROYAL SOCIETY OF ARTS, at 8.—Dr. A. Scott: The Restoration and Preservation of Objects at the British Museum.

THURSDAY, FEBRUARY 23.

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INSTITUTION OF ELECTRICAL ENGINEERS, at 3.30 and 8.—Meeting in Commemoration of the First Meeting of the Society of Telegraph Engineers on February 28, 1872.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—C. D. Ellis: β-ray Spectra and their Meaning.—Prof. A. E. Conrady: A Study of the Balance.—Dr. J. S. Owens: Suspended Impurity in the Air.—R. V. Southwell: The Free Transverse Vibrations of a Uniform

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CHILD-STUDY SOCIETY (at Royal Sanitary Institute, 90 Buckingham Palace Road, S.W.1), at 6.—A. E. Hayes: Phonoscript.

CONCRETE INSTITUTE, at 7.30.—H. K. Dyson: What is the Use of the Modular Ratio?

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JUNIOR INSTITUTION OF ENGINEERS, at 8.—E. G. Coker: Curved Beams, Rings, and Chain Links.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. Joly: The Age of the Earth.

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(*A number in brackets indicates the number of a lecture in a series.*)

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KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (5).—M Beza: Nereids in Roumanian Folklore (2).

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KING'S COLLEGE, at 5.—Prof. R. Robinson: Orientation and Conjugation in Organic Chemistry from the Standpoint of the Theories of Partial Valency and of Latent Polarity of Atoms (2).

UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (2).

TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (4).

SATURDAY, FEBRUARY 18.

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LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (5).

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: A Botanist in South Africa.

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CITY OF LONDON (BOYS') SCHOOL (Victoria Embankment), at 5.30.—Miss Rosa Bassett: The Dalton Plan of Self-education (3).

KING'S COLLEGE, at 5.30.—Prof. C. L. Fortescue: Wireless Transmitting Valves (5).

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SCHOOL OF ORIENTAL STUDIES, at 5.—Col. T. C Hodson: The Primitive Culture of India (5).

IMPERIAL COLLEGE (Royal School of Mines), at 5.30.—Col. N. T. Belaiew: The Crystallisation of Metals (1).

KING'S COLLEGE, at 5.30.—F. H. Rolt: Accurate Measurements in Mechanical Engineering: The Use and Testing of Gauges (3).

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 6.—Sir Josiah C. Stamp: The Administrative Factor in Government (2).

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LONDON (R.F.H.) SCHOOL OF MEDICINE FOR WOMEN (Hunter Street, W.C.1), at 5.—Dr. H. H. Dale: Some Recent Developments in Pharmacology (1).

HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (5).

UNIVERSITY COLLEGE, at 8.—The Current Work of the Biometric and Eugenics Laboratories (2).—Miss Ethel M. Elderton: The Inheritance of Intelligence.

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UNIVERSITY COLLEGE, at 5.15—Prof. J. E. G. de Montmorency: Welsh and Irish Tribal Customs (3).

KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (6).

ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN (Leicester Square, W.C.2), at 6.—Dr. W. Griffith: The Bullous Eruptions (Chesterfield Lecture).

BIRKBECK COLLEGE, at 8.—G. Bernard Shaw: The Failure of Education.

FRIDAY, FEBRUARY 24.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (6).

CANCER HOSPITAL (Fulham Road, S.W.3), at 4—W. E. Miles: Cancer of the Rectum.

UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (3).

TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (5).

SATURDAY, FEBRUARY 25.

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The Function of English in Scientific Education.

THE Report of Mr. Fisher's Committee on the Teaching of English in England (pp. 394, H.M.S.O., 1921, 1*s*. 6*d*. net) has a refreshing novelty of outlook. As the serious study of English in the schools has an even shorter history than that of science, this Committee is little affected by pedagogic prejudices and vested interests, so that it is bold enough to treat all subjects taught in schools as coming within one or other of two groups, English and Science.

This classification calls for wide definitions; it is laid down that "in school, science must be, for teacher and for student, the methodical pursuit of truth and the conquest of the physical world by human intelligence and skill." The term "English" has in the past been interpreted in many ways. The public-school master of thirty or forty years ago would think of it as connoting geography, the history of England, and a little analysis and parsing, syntax and accidence. The Committee's definition is very different; it does not concern itself primarily with history or geography or with the study of language, but with the English language as a means of communication, oral and written, and with the content of books written in English as a storehouse of ideas, whether native or translated, and as an agent of emotional and æsthetic culture. Thus education is divided into "the training of the will (morals), the training of the intellect (science), and the training of the emotions (expression or creative art)," corresponding to the view that "the three main motives which actuate the human spirit are the love of goodness, the love of truth, and the love of beauty."

A separation of function of this kind has some value, if only to make us realise the necessity of each of the different components of a complete education. In practice, however, any one subject of study can and does perform several functions, overlapping those of other subjects which are akin to it. Thus some aspects of the study of English are of essential utilitarian value to a man of science, such as training in the power to write or speak clearly, lucidly, without ambiguity or prolixity, and if possible with a sense of style such that the reader may be attracted as well as instructed. But this power cannot be developed in the student without traversing much of the same ground as would be covered if the chief aim were the development of other faculties. So there will be economy of time and effort if English is used as the vehicle for an education in the humanities. It is universally agreed that, even for full efficiency in his own department, the science specialist must have such an education; it is the chief concern of the Committee to show how completely English can be made to fulfil that function.

The Committee mentions with approval the methods which have been developed at Osborne and Dartmouth in the training of naval cadets for their future career, which may be regarded as predominantly scientific, but in which they will need all the faculties of a liberally educated mind and character. For they may have to be diplomatists, tacticians, and strategists, and must certainly be leaders of men no less than practical scientific workers; they must be equipped for controlling minds as well as machines. This problem is not peculiar to the Navy, though perhaps it is more obvious there owing to the close contact, under one controlling authority, between those who train and those who employ the product of the naval college, a contact closer than is practicable, for example, between schoolmasters and leaders in the business world. Hence the experience of Dartmouth may be of more than local interest.

It says much for the prescience of the Admiralty that it should have committed itself, so far back as 1903, on the advice of the eminent man of science, Sir Alfred Ewing, who was then Director of Naval Education, to the faith that, given adequate time and skilled treatment, most of the values hitherto judged to accrue solely from a classical education were to be derived from the study of English. The experience gained during the past eighteen years in acting on this belief has gone far to justify it, and it is satisfactory to note that the methods which have been elaborated are in close

agreement, both in principle and detail, with those recommended by the present Committee.

There is little necessary connection between the study of the humanities and the teaching of languages; the latter properly falls under the head of a science, and the traditional connection arises from both having formerly been the province of one group of men. Before the days of the conflict of studies, the time devoted to Latin and Greek was far greater than was needed for the languages themselves, and the remainder was well spent on Literæ Humaniores. The present Report deals admirably with the question of the scientific and grammatical study of language; sections 254 to 266 are well worth reading in their entirety; but we are not concerned at the moment with the training of language specialists; we are, however, deeply interested in the problem of transferring to the teacher of English the functions formerly performed by the classics master in connection with the humanities. The first requisite for this transfer is to provide teachers adequately cultured; the next is to ensure the right use by them of the material available.

The Committee, therefore, had to decide what are the right methods of teaching; it also had to consider what modifications in these methods are appropriate to public elementary and preparatory schools, continuation, commercial, and technical schools, teachers' training colleges, and the universities; in addition, it felt constrained to prove that too little importance at present attaches to the study of English in all these institutions. Hence the Report covers so much ground that some search is needed to discover the teaching methods advocated.

A few extracts may, however, give some idea of the Committee's views. In commending recent progress it says:

"Exercises in both descriptive and imaginative writing, as well as practice in verse composition, in letter writing, and in dialogue, are common in the early stages. Many interesting experiments have been tried with a view to encouraging self-expression. These include debates, improvised dialogues, and dramatic scenes, and ten-minute lectures by pupils, in class as well as in out-of-school hours." "There is a far wider range of reading than formerly. . . . Rapid and enjoyable reading is no longer an exceptional thing; the class themselves take more part in the lesson and express their likes and dislikes freely." . . . "Not less important than the art of writing is the art of speaking, which includes practice not only in framing questions and answers, but also in reading aloud, recitation, debating, and drama." "A reasonable study of phonetics by the teacher should enable him to give guidance and to correct some of the most common and jarring mistakes of pronunciation." "The rendering of literature by the voice is not a mere matter of mechanical correctness, but is the final result of sympathetic entry into the spirit of the writer, and without it no education in letters can be complete."

The interest in lessons on such lines need never flag; but a note of warning is sounded. Since the reading and writing of English have an intimate and personal touch for the Englishman, they form a perfect medium for a humane education, but there is a possibility that an enthusiast may press this advantage too far and thrust himself unbidden into an inner sanctuary of the adolescent soul. It is significant that the Committee has received warning of this danger from headmasters of public schools, and not from other teachers, for a man who works in boarding-schools is apt to know more of the real boy and his reticences than the master in a day school. Hesitation on these grounds differs fundamentally from the objections of the conservative teacher whose sense of the ludicrous is stimulated by the thought of his class criticising a great author or acting scenes from a play, or of the disciplinarian who prefers the rigidity of dullness to the apparent disorder of a vividly interested class, or even of the man who feels that literature would be spoiled for the student by being read in school; but the Committee is probably right in holding that the danger is not great, and that in any event the gain is worth the danger.

In fine, to discover a medium of education in the humanities which is applicable to all sorts and conditions of Englishmen has been a vexed problem for many years, and the Committee has made an excellent case for leading us from the Abana and Pharpar of the classics to wash in the Jordan of English in order to secure a healthy and truly national system of education.

Calcium Carbide and the Board of Trade

WHAT'S A WORD WORTH?

"'THE question is,' said Alice, 'whether you *can* make words mean so many different things.'

"'The question is,' said Humpty Dumpty, 'which is to be master—that's all.'"

IT is written: "A rose by any other name would smell as sweet"; perhaps, yet there are occasions when a name may be costly to play with. One of these occurred recently, an amount running into thousands of pounds having, it is said, changed hands in the effort to disestablish the meaning of a name. Called upon to interpret the Act, christened by our Legislature the Safeguarding of Industries Act but more appropriately described as an Act for

"The Sterilisation of Scientific Inquiry, the Retardation of Industry and the Stay of Progress in Education," an Act which penalises all our scientific workers, the lawyers have been disputing over the term *Chemical* and have practically decided that it has no meaning. They have toyed with the doublet *Organic Chemical* and their dialectics have landed them in the conclusion that chemists do not in the least know where they are—so they proceed to tell them where they are not. The decisions read like those given in Wonderland, being on strictly "Humpty Dumpty" lines; they are akin to his famous reading of "*toves*":

"Well, '*toves*' are something like badgers—they're something like lizards—and they're something like corkscrews."

Now a wrangle is on over *Fine Chemical*, a term that has never been defined and is indefinable.

According to the Schedule to the Act, protection is given to "All synthetic organic chemicals . . . analytical reagents, all other fine chemicals and chemicals manufactured by fermentation processes."

The Board of Trade, putting its own interpretation upon these words, has produced a very long list of dutiable chemicals; but this is deemed so imperfect that several hundred applications have been lodged to amend it. One of the articles not on the list is Calcium Carbide and an inquiry has been held, at intervals lasting over many weeks, into the legitimacy of the claim that this substance is a synthetic organic chemical, to be ranked in the army of the protected.

An advocate learned in the law but without knowledge of chemistry, sitting unassisted by an expert assessor, after hearing many witnesses for and against, no one of whose testimony, it is obvious, could he well appraise, without attempting to deal with the adjective "synthetic," has pronounced that the carbide is not even an organic chemical.

Given such a tribunal, the issue is obviously a matter of chance; chemists would be equally unable to decide with justice in cases into which purely legal considerations entered. Still, the decision is a serious reflection upon the mental attitude of the chemist—upon his failure to think and speak only in precise terms. Unfortunately the "Ignorance of the Learned"—Hazlitt's memorable phrase—is always with us.

Calcium carbide, as every motorist and most intelligent people to-day know, gives acetylene as sole gaseous product when water is dropped upon it, the hydrogen of the water being exchanged for the calcium of the acetylide (carbide) and *vice versa*. The synthesis of acetylene, from carbon and hydrogen at the temperature of the electric arc, was first effected in 1859 by Berthelot. That the distinguished French chemist had no doubt of the organic nature of the compound is clear from the fact that he describes the method in his "Chimie Organique fondée sur la Synthèse" and also in his "Leçons sur les Méthodes générales de Synthèse en Chimie Organique" (1864). Practically speaking, it is the fundamental synthesis of organic chemistry, the foundation upon which the vast series of constructive processes which render the science so remarkable has been developed.

If there be one word in use in chemistry which, after long dispute, has a defined and accepted meaning, it is the word "organic." The dispute began with Wöhler's discovery, in 1828, that urea—the organic compound which every human being voids daily in considerable quantity—could be made by a purely artificial process: the birth of synthetic organic chemistry is to be dated from that moment; structural chemistry became possible only after Frankland had introduced the conception of valency (1852). Then system began. The prince of systematists, Kekulé, in 1851, first defined Organic Chemistry as the Chemistry of the Carbon Compounds. Others followed him. When Schorlemmer, considerably later, suggested as the better definition—The Chemistry of the Hydrocarbons and their Derivatives—he took care to point out that "compounds containing one atom of carbon such as CO_2, $COCl_2$, CS_2, HCN, which are commonly described in the inorganic part, are as much derivatives of marsh gas, CH_4, the most simple hydrocarbon, as methyl alcohol and formic acid." In his "Rise and Development of Organic Chemistry," in discussing a series of organic syntheses, he makes special reference to that of acetylene and immediately afterwards remarks: "after this the synthesis of organic compounds made rapid progress."

What does it matter where the chemist may choose to describe a carbon compound, as a matter of convenience and policy, to-day? To put port into a lower instead of into an upper bin does not change the wine to sherry. No legal dialectics can depose a substance from its proper place in the chemist's system.

In fact, the decision of the Board of Trade Referee is an offence against both chemical tradition and our chemical conscience. Appeals, with reference to chemicals, under the Act, if they are to be heard justly, should be submitted to a tribunal of chemists learned in chemical science, not to an arbitrator only learned in the law, whose attitude can but be that of "Humpty Dumpty." H. E. A.

The Pioneer of Non-Euclidean Geometry.

Girolamo Saccheri's "Euclides Vindicatus." Edited and translated by G. B. Halsted. Pp. xxx + 246. (Chicago and London: The Open Court Publishing Co., 1920.) 10*s*. net.

THIS work is an important classic, which is well worthy of inclusion in the valuable series brought out by the Open Court Publishing Co.

Sir Henry Savile, in his lectures of 1620 on Euclid I., published at Oxford in 1621, had said that in his judgment there were two blemishes (*naevi*) or blots (*labes*), and no more, in the fair body of geometry, the first being the parallel-postulate, and the second the definition of "compound ratio" in Book VI. (a definition now known to be interpolated). Saccheri's "Euclides ab omni naevo vindicatus" dealt with both *naevi* in parts 1 and 2 respectively, and from the wording of his title we may fairly infer that it was the Englishman who gave the Italian Jesuit the motive for his epoch-making treatise—that of defending Euclid and proving (if he could) that Euclid's work contained *no* flaw. The present edition is confined to part 1, on the parallel-postulate, which is alone important. Saccheri must be called the pioneer of non-Euclidean geometry, for, although it was his object to establish the truth of the Euclidean postulate once for all by showing that all hypotheses other than that of Euclid are false, he was the first to contemplate the possibility of such other hypotheses and to follow them out to a number of consequences. He is therefore, as Beltrami observed, a true precursor of Legendre and Lobachewsky, and, it might be added, of Riemann also.

Saccheri starts with a quadrilateral formed by a given straight line as base, two perpendiculars of equal length erected from the extremities of the base on the same side of it, and the straight line joining the other extremities of the equal perpendiculars. The angles made by the latter straight line with the perpendiculars respectively are easily proved to be equal. There are then, says Saccheri, three possible suppositions—the two angles may both be (1) right angles (the Euclidean hypothesis), or (2) obtuse angles, or (3) acute angles. Saccheri calls these the hypothesis of the right angle, the hypothesis of the obtuse angle, and the hypothesis of the acute angle respectively, and the object of his treatise is to prove the absolute falsity of the last two hypotheses. His proof in the case of the obtuse angle depends on the universal validity of Euclid I. 16 (which excludes the Riemann hypothesis), while his proof in the case of the acute angle is even less successful. He nevertheless proves certain important propositions afterwards proved by Legendre, Lobachewsky, and Bolyai.

Saccheri lectured on philosophy and theology, as well as mathematics, and he wrote an important logical work, the "Logica demonstrativa," brought to light by Giovanni Vailati in 1903. He was otherwise an interesting personality. We are told that he had a passion for truth, and in his pursuit of it he would (like Archimedes) neglect his person, his food, his clothes, and his comforts. As a boy of five he was a calculating prodigy. Later he became a great chess-player, being able to play (and generally to win) three games simultaneously without seeing the boards, and, as if this were not enough, to talk to people around him and also to think out some abstruse geometrical problem at the same time; afterwards he would repeat all three games from memory.

Prof. Halsted has important qualifications for editing Saccheri's treatise. He is himself an authority on non-Euclidean geometry, and has an unbounded enthusiasm for his author, which we welcome even when it leads him to write such sentences as "So flowered the beauteous body of a new geometry, mermaid-like, the latter portions somewhat fishy, but, oh! the elegant torso." It is all the more unfortunate that his execution of his task proves in many respects disappointing. The introductory matter, mainly historical, is fairly adequate, but even here there are sins of omission and commission. When he says that Father Manganotti, S.J., "accidentally discovered" Saccheri in 1889, "re-discovered" would be a better word. For Saccheri's work was thoroughly examined in Klügel's dissertation, "Conatuum praecipuorum theoriam parallelarum demonstrandi recensio" (1763), certain details about it are given in Camerer's Euclid (vol. 1, 1824), C. F. A. Jacobi mentions it (1824), and it can scarcely have been unknown to Gauss and Lobachewsky.

On pp. xviii–xix Prof. Halsted pays the editor of "The Thirteen Books of Euclid's Elements" the compliment of quoting word for word (without inverted commas) a whole page from his description of Saccheri's "Logica demonstrativa." Almost in the same breath (p. i of preface) he charges the same editor with supposing that Saccheri's "Euclides ab omni naevo vindicatus" was a "Latin edition of Euclid," a baseless charge which he need not have made if he had read the other passages of the raided work where the editor gives not only a detailed description of the book now in question, but also three long citations of proofs by Saccheri of his own propositions with diagrams, which certainly never appeared in any "edition" of Euclid. Nor is there any excuse for Prof. Halsted's omission to mention the German translation of Saccheri in Engel and Stäckel's "Die

Theorie der Parallellinien von Euklid bis Gauss" (Leipzig, 1905), a better translation, and better annotated, than his own.

To come to the translation: Prof. Halsted quotes a remark by "one of the foremost classical scholars in America" that the Latin of Saccheri is almost classical and is remarkably clear. It is a pity that it should not have been translated into equally classical English. The translation is, in fact, the reverse, and it is clear that the translator was not well equipped for this part of his task. He seems imperfectly acquainted with the force of "quin," twice mistranslating it completely; apparently he does not know the meaning of "morem gerere," since he translates "ut morem gereret tot Magnis viris . . ." by "as made a custom with so many great men . . ." (!); he renders "in rem suam" by "in his affair" instead of "for his purpose," "superetur ab" by "would exceed" instead of "would be exceeded by," "liquet" by "it flows" instead of "it is clear," "dico . . . manifestae falsitatis redargui inimicam hypothesim" by "I say I have disproved the hostile hypothesis by a manifest falsity" instead of "I say I have convicted the hostile hypothesis of manifest falsity," "ad tuendas reliquas Definitiones" by "regarding other definitions" instead of "for the purpose of maintaining other definitions." He is habitually vague as to moods and tenses, commonly translating the subjunctive by the indicative, future by present, etc. And what are we to say of such a sentence as this: "But here (*vice versa*) in fact is permitted the designation of however most small an acute angle at the point A while still the sect AB to which is to be erected the indefinite perpendicular BX, may be taken of any length whatever"? The mathematician must make of this what he can. For our part, here and in many places, we find it a relief and comfort to be able to turn for light to the Latin on the opposite page.

The Structure of East Africa.

The Rift Valleys and Geology of East Africa. By Prof. J. W. Gregory (with ten appendices by various authors). Pp. 479 + 20 plates + 5 maps. (London: Seeley, Service, and Co., Ltd., 1921.) 32s. net.

PROF. GREGORY is to be congratulated on having found, or made, opportunity to complete his work in East Africa, begun so brilliantly and adventurously in 1892–3. Returning to the country for a short visit in 1919, under favourable auspices and vastly improved conditions, he was able to collect much new information in rapid traverses, often by motor-car, where, as we are now reminded, on his previous journey his researches had been curtailed by the truculence of drunken warriors, or by drought, scarcity of game and ferocity of lions, or other such amenities of the old "safari" travel. Meanwhile there has been considerable exploration of this and neighbouring regions by other observers, and Prof. Gregory has essayed in the volume before us to combine what is known of the geology of East Africa into a coherent whole. That he has performed the task with courage and skill need scarcely be said; every scrap of information finds its appropriate place in his scheme and helps to consolidate it, so that we have a clear and logical account of the geological history of the region throughout the ages. All the rocks are classified into formations with local names and placed in position in the geological scale.

With the present meagreness of our knowledge of these vast spaces, there may seem to be a premature positiveness in the method of presentment, but the author defines his attitude explicitly in his preface: "Progress in East African geology requires a scheme by which new facts may be classified. The classification adopted is tentative and must be amended as well as amplified. Pioneer geology has to choose between the rashness of using imperfect evidence or the sterility of uncorrelated, unexplained facts." These sentences must be remembered by the reader; otherwise he may sometimes be startled at the big leap, taken with a bold "therefore," from the narrowness of the stated fact to the breadth of the deduction. Used in accordance with the author's suggestion, as an adjustable framework to accommodate new information, the book will be of particular service to every future worker in the same field, while to the geologist at large it provides the readiest means of gaining a general idea of the eastern portion of the African continent.

As implied by the title, Prof. Gregory's well-known and much-discussed conception of "the Great Rift Valley" runs as a leading theme throughout, and monopolises the shorter two of the four parts into which his book is divided. This is, however, largely a repetition, with some modification, of matter already published, here conveniently reassembled. It is parts 2 and 3, with the technical appendices, that constitute the major and most serviceable portion of the work

In part 2, consisting of twenty-two chapters, the author describes the geology, mineral resources, etc., of British East Africa (now Kenya Colony). This part contains the details of the new observations made by the author in his recent traverses; hard reading for anyone unacquainted with the ground, but invaluable to the next investigators in exhibiting the evidence on which the generalisations and classi-

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fications are based. The recently issued first Annual Report of the Geological Department of the Uganda Protectorate prepares us for future keen discussion on several points in the proposed classifications. Some notes on prehistoric man and on caves, water supply and soils, at the end of part 2, with further information in the appendices, are of general interest. The numerous geological sketch-maps and sections in the text, though effective in a broad way, are roughly drawn and poorly printed, so that the deciphering of their detail is often troublesome. Though unavoidable, the big exaggeration of the vertical scale in all the sections, with the consequent severe distortion of the slopes, should be constantly borne in mind, since it may profoundly affect the interpretation of the structures, particularly where questions of faulting are concerned.

In part 3 our present knowledge of the stratigraphy of the neighbouring countries of East Africa and of other regions supposed to be linked up with the "Great Rift" is usefully summarised in short chapters dealing successively with Uganda and the lakes, Tanganyika Territory, Nyasaland, Madagascar, Somaliland, and Abyssinia, with some reference also to the Nile Valley and Red Sea and to the Palestine trough. A full bibliography, thirty pages in length, forming one of the appendices, adds to the value of the volume as a book of reference.

The book is embellished by some excellent reproductions of scenic photographs as plates. The diagrammatic folding-maps are adapted from those in the author's paper on African rift valleys in the *Geographical Journal* (July, 1920), and have no geological detail.

With respect to the main theme, Prof. Gregory has presented in his final chapter a lucid and concise retrospect of his opinions. He still holds that a great rift valley, stretching for more than one-sixth of the circumference of the earth, was formed by the subsidence of strips of the earth's crust between parallel tension-faults, consequent upon the breakdown of a precedent broad arch of elevation. He believes that this structure can be traced in the features of the present surface all but continuously from Palestine, by way of the Red Sea and Abyssinia, across East Central Africa, southward to the south-east coast beyond the Zambezi; with branches, eastward into the Gulf of Aden, and westward, by way of the Central Lakes, into the Upper Nile valley. The production of the "Great Rift" is assigned to movements affecting the entire earth between Upper Cretaceous and Pliocene times, and the whole story of these movements is outlined.

It may be so. Anyhow, the idea has its value as a clear-cut working hypothesis. But we really do not know much that is definite yet about the structural features on which the hypothesis rests; and as closer investigation is now in progress at many points along the supposed course of the "Rift," we may expect soon to have better grounds for judgment. Already the existence of the "Rift" along the Red Sea has been called in question by the officers of the Egyptian Geological Survey; and in Uganda the features of the "Western Rift" are pronounced by their latest investigator to be indicative of movements of compression and not of tension (*Geograph. Journ.*, November, 1921). It is generally agreed that the deep troughs of Central and East Central Africa are due to tectonic movement, with which severe faulting is associated; but it remains to be seen whether the troughs can be strung together into a continuous chain of the length and character assumed on the "Great Rift" hypothesis. Meantime let it be acknowledged that in this volume Prof. Gregory once more proves himself to be the capable champion of a bold conception which has already served, and will further serve, for fertile controversy and the increase of earth-knowledge.

G. W. L.

The Quantum Theory.

Die Quantentheorie: Ihr Ursprung und ihre Entwicklung. By Fritz Reiche. Pp. vi+231. (Berlin: Julius Springer, 1921.) 34 marks.

THIS is an admirable account of the whole field of the quantum theory, and should be very useful to anyone who has not followed it from its origin. In a subject like this, which is not yet organised into a consistent whole, it is often exceedingly difficult to judge the importance of any particular branch of the theory. One reads a paper, but cannot form an estimate of its real value, because there is not at hand all the information on cognate subjects. This is especially true of the quantum theory, for the literature is very predominantly German, and it is customary in Germany to permit the publication of much more speculative ideas than is usual in other countries, and the result is that the truth tends to get lost in the mass of paper. The great merit of the present book is that it brings together all the threads of the argument and criticises them, so that a just view can be obtained of the whole theory without struggling through a vast quantity of literature of which a good deal is of little value. It is not a mere compilation of all the views which all writers have held at all times, but a critical estimate of the opinions at present generally accepted.

The book contains 161 pages of text. The mathematics are relegated to a further seventy pages of notes, and the arrangement of these is rather tiresome, for the majority of the notes are simply references to original papers, and there is nothing in the text to distinguish between these and the mathematical calculations.

The order of treatment of subjects is mainly historical, and radiation therefore comes first. This is probably the best arrangement possible at present, though when the theory has been reduced to a classical form it is to be presumed that such a complex question will fall into a much later position. There follows a short discussion on the necessity of breaking away from ordinary mechanics, and then a description of Einstein's hypothesis of light quanta, and the ingenious deductions he makes from the fluctuations in radiant energy. The fourth chapter gives an account of the quantum theory in relation to the physics of solids—such questions as specific heats and Born's work on the dynamics of crystals. The next chapter deals with gases, where the theory is not quite so satisfactory. The rest of the book is mainly occupied with the Bohr theory. It includes all the more recent ideas, such as the correspondence principle, and also a certain amount about atom models.

There is little to criticise in such a fair account of the whole theory, but we may venture to say that the author is perhaps inclined to favour Planck's second hypothesis rather more than would the general consensus of present opinion. That hypothesis seems to give rather better agreement with experiment in the theory of gases, but neither of Planck's hypotheses has yet been made to cover the facts in a really convincing manner. On the other hand, the second hypothesis is quite foreign to the principles of spectrum theory, which agree exceedingly accurately with experiment. Apart from this, anyone wishing to get a just view of the quantum theory cannot do better than read the book.

Our Bookshelf.

Taboo and Genetics: A Study of the Biological, Sociological, and Psychological Foundation of the Family. By Dr. M. M. Knight, Dr. Iva L. Peters, and Dr. Phyllis Blanchard. Pp. xv + 255. (London: Kegan Paul and Co., Ltd.; New York: Moffat, Yard, and Co., 1921.) 10*s.* 6*d.* net.

THIS survey of the institutions connected with sexual life and the family falls into three sections. In the biological section Dr. M. M. Knight gives a lucid summary of recent work on sex, drawing the conclusion that the difference between the sexes is quantitative rather than qualitative. In the second section Dr. Iva Peters surveys the ethnological evidence for the taboo of women, and concludes that the modern form of monogamous marriage is essentially a survival of a compromise between man's erotic desires and his fears of woman's *mana*, which has produced an "ideal woman," a type out of harmony with modern developments. This is perhaps the least satisfactory of the three sections. By dwelling too exclusively on taboo and its results it ignores equally important factors in the various social complexes which influence the institution of the family. Dr. Phyllis Blanchard, in dealing with the psychological side of the question, has provided the most stimulating section of the book. By a skilful analysis she places before her readers the chief elements which are responsible for disharmony in modern marriage and the causes which, partly through the increased social activities and individualism of women, are bringing about the exclusion of a large body of the female population from participation in carrying on the race.

Sulphur and Sulphur Derivatives. By Dr. H. A. Auden. (Pitman's Common Commodities and Industries.) Pp. xviii + 101. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) 3*s.* net.

DR. AUDEN gives a very readable and accurate account of the manufacture and uses of sulphur and its derivatives, especially sulphuric acid, and his book should prove useful to students and general readers. Although two illustrations of the Gill furnace are given, its mode of operation (which cannot be seen from the illustrations) is not mentioned. The changes observed on heating sulphur are not quite correctly described (p. 5). Moreover, the statement (p. 29) that "almost the whole supply of ammonium sulphate is at present derived from the distillation of coal" refers only to English practice; in more progressive countries very large quantities are produced from atmospheric nitrogen. Although the earlier history of the contact process is given, the real commercial process (p. 61) is not ascribed to any particular inventor—the work of the Badische Co. would seem worthy of mention, and diagrams of the apparatus would also be useful.

Examples in Optics. Compiled by Dr. T. J. I'A. Bromwich. Pp. 16. (Cambridge: Bowes and Bowes, 1921.) 2*s.* net.

DR. BROMWICH has collected sixty questions in optics for use in class-room at St. John's College, Cambridge, and has given references to eighty-four Tripos questions set between 1910 and 1921. The examples printed in the pamphlet cover a fairly wide range, and have evidently been selected by an experienced teacher. In many cases the questions have a direct practical application, or point towards a method of making some important optical measurement. Special attention may be directed to the examples connected with the cardinal points of a system of lenses or refracting surfaces, which should prove a useful supplement to practical work in the laboratory.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Transport of Organic Substances in Plants.

THE older writers and modern text-books affirm that the organic materials (carbohydrates, etc.) manufactured in the leaves of plants are transported downwards by means of the bast through their organs to places of consumption and storage. This belief seems to be based entirely on ringing experiments. *A priori* the bast appears to be very unsuitable for carrying out this function. Even in the most rapidly assimilating plants its cross-section is small. It is formed of short cells and comparatively short, narrow tubes, so that many cross-partitions must be traversed by the stream carrying these organic substances if they use it as a conduit. Furthermore, its resistance must be greatly increased by the fact that a large proportion of its cross-section is occupied by viscid contents—protoplasm and proteins. Evidently, in such a conduit we could only expect that velocities of transport comparable with diffusion velocities could be attained. Assuming that a 10 per cent. solution of sucrose were supplied by the leaves and that this was completely converted into an insoluble carbohydrate in a storage organ 50 cm. distant, then we might expect, after a steady state had been attained, a rate of transport, from diffusion alone, of about 2 milligrams per sq. cm. per diem. This would be equivalent to a 10 per cent. solution moving at the rate of 0·2 mm. per diem. Although this diffusion rate of transport might be somewhat accelerated by protoplasmic streaming, it is quite evident that diffusion in the bast is inadequate to account for the observed rate of transport of carbohydrates in plants. The insufficiency of diffusion to transport carbohydrates is strikingly borne out by those experiments in which cut floating leaves exposed to conditions suitable for photosynthesis accumulate carbohydrates, while only negligible quantities find their way into the water.

Close approximation to the velocity of transport in the bast, if that channel alone is used, may be obtained.

For example, a potato weighing 210 grams was attached to a stem by a slender branch about 1·6 mm. in diameter. In this branch the bast had a total cross-section of 0·422 sq. mm. This figure is a maximum, as no allowance was made for cell-walls or any non-functional element in the bast. Through this conduit, *ex hypothesi*, all the organic substance has passed during the growth of the tuber, viz. in about 100 days. According to analyses, more than 24 per cent. of the tuber is combustible; therefore we may assume that approximately 50 grams of dissolved carbohydrate has passed a conduit 0·422 sq. mm. in cross-section in 100 days. The concentration of this solution was probably not more than 10 per cent. Thus 500 c.c. of solution must have passed in 100 days, and the average rate of flow must have been 5/0·00422 cm. per diem, *i.e.* more than 1000 cm. per diem, or about 40 cm. per hour. This is evidently a much greater velocity than could be attained by diffusion in the bast, even when assisted by protoplasmic streaming.

Another way of arriving at the velocity of transport in the bast demanded by this view may be obtained from such recorded results as those of Brown and Morris on the depletion of leaves. When these results are combined with actual measurements of the total cross-section of the bast strands in the petiole we arrive at similar figures for the velocity of transport, *i.e.* if carbohydrate moves as a 10 per cent. solution the velocity of flow must be approximately 50 cm. per hour.

These considerations irresistibly force one to conclude that the cross-section of the bast is not adequate to transmit the amounts of carbohydrates actually known to travel downwards in the stems and petioles of plants. The same arguments seem to apply in ruling out the cortex as the conduit for the general transport of carbohydrates. The greater cross-section available would still be insufficient to allow the quantity transmitted by diffusion alone to account for the quantities observed.

In this connection a fact pointed out to us by Prof. Seward is of peculiar interest. In several species of tree-like Lepidodendra there is no tissue in the stem which presents the structural characteristics of bast, yet we cannot possibly assume that no transport of organic substances back from the photosynthetic organs took place in Lepidodendron.

Many observations indicate that the wood is the tissue in which this transport is effected. Hales, in 1727, published accounts of experiments showing a reversed or downward current in the stem of trees. One of us and Dr. Joly experimented with inarched branches and demonstrated a reverse current, and quite recently Ricca's brilliant work on the transport of the hormone in Mimosa renders the same phenomenon obvious (Boll. della Soc. bot. Ital., Ott., 1915, "Soluzione d'un Problema di Fisiologia," Firenze, 1916). Many observers have proved the presence of carbohydrates in the water of the tracheæ during spring, and one of us, with Dr. W. R. G. Atkins, has shown that these substances are present in a greater or less degree during the entire year (H. H. Dixon and W. R. G. Atkins, Notes from the Botanical School of Trinity College, Dublin, vol. 2, pp. 275 *et seq.*). It is only reasonable to assume that they will travel with the water current whether it moves in an upward or downward direction.[1]

Some very striking evidence for the existence of this reversed current may be obtained with plants of *Solanum tuberosum*. Thus a large potato plant was dug up from the soil with as little injury as possible to its underground stems and roots. After a short exposure to the air, but before any visible wilting had taken place, the apex of one of the leaves was cut off under a solution of eosin by means of a pair of scissors. In an hour the veins of all the leaves, the stems, and the roots were tinged with eosin. Even the roots on the far side of the tuber showed this coloration. When sections of the tuber were examined next day the strands of tracheæ in the bundles showed out with great clearness owing to their injection with eosin. This experiment was made in September.

A similar result was obtained with a specimen of *Chrysanthemum macrophyllum* left undisturbed as it grew. The tip of one of the leaves was cut off and the cut surface immersed in eosin solution at 4 p.m. on an October afternoon. Next morning the eosin was apparent in all the veins of the leaf and could be traced in the bundles of the petiole.

The transmission of clogging and poisonous substances by a reversed transpiration current has been

[1] Lately Curtis has criticised this view, basing his attack on the results of ringing experiments. He does not, however, seem to have taken into account the blocking of the tracheæ which results from morbid changes spreading inwards through the wood parenchyma and medullary rays from the injured region. These effects have been discussed at length by Strasburger, "Leitungsbahnen in den Pflanzen."

demonstrated by one of us (H. H. Dixon, Notes from the Botanical School of Trinity College, Dublin, vol. 2, pp. 5 *et seq.*) in the case of *Tilia microphylla*, *Syringa vulgaris*, *Salix viminalis*, and Philadelphus sp. Similarly, Luise Birch-Hirschfeld (*Jahrb. f. wiss. Bot.*, Bd. 59, pp. 171 *et seq.*) has shown that a solution of lithium nitrate may be carried considerable distances downwards in the reversed transpiration stream of various trees, shrubs, and herbs.

Naturally the question obtrudes itself as to how a downward current of dissolved carbohydrates is produced in the wood which is also the normal channel of the upward transpiration current. The subject calls urgently for investigation, and it may not be out of place to mention some of the hypotheses which must be tested.

If it could be shown that the wood of the vascular bundles were divided longitudinally by more or less impermeable partitions into isolated tracheal strands, we might suppose that the tension developed in the water in some of these strands by transpiring cells, while raising the sap in these, might draw down solutions ejected by adjacent cells in neighbouring strands. No such vertical partitions have been described, unless the late summer wood or the vertical plates of parenchyma in the leaf veins and petioles be regarded as such. With such longitudinal partitions a continuous and contemporaneous upward and downward transport might be developed.

An intermittent downward flow might be explained if we could obtain evidence of a periodic or occasional development of permeability in the protoplasmic utricle of the transpiring cells. This might be developed in response to any stimulus, *e.g.* the mounting of tension in the adjacent sap above a certain limit.

The periodic mounting of tension with consequent contraction of the stem, which is indicated in the experiment on the potato plant quoted above, has been established by the elegant observations of Mallock (Proc. Roy. Soc., 1919, vol. 90, B, pp. 186–91) and of MacDougal ("Growth in Trees," Carnegie Institution of Washington, Washington, 1921). These latter show graphically the change of volume of the woody stem of forest trees corresponding to the diurnal period.

Again, the deposit of dew on the transpiring cells, in conjunction with a high tension, might determine a downward flow in the tracheæ, and, with suitable modification of the permeability of these cells, this downward stream might be charged with dissolved carbohydrates.

It is quite evident that the tension assumed here may be developed by temperature changes of the water in the woody tissues and by recovery from flexure just as well as by evaporation. That tension is really responsible is indicated by the experiments quoted above, and also by the fact that no transport occurs from cut leaves floating in water.

If the view that the longitudinal transport of organic substances takes place in the tracheæ is established, speculation naturally arises as to the function of the bast. While the form and arrangement of this tissue seem to preclude any important longitudinal transmission within it, its large peripheral surface and the area of its contact with the cambium and medullary rays seem to suit it for the transmission of organic substances in a radial direction. In this connection the medullary rays may have the function of discharging into, and extracting from, the tracheæ organic substances which are transmitted to and from them by the bast. The observations made by Atkins and one of us that the concentration of carbohydrates in the conducting tracts often diminishes from below upwards suggests that these substances may be extracted from the transpiration current in its upward movement (H. H. Dixon and W. R. G. Atkins, Notes from the Botanical School of Trinity College, Dublin, vol. 2, pp. 335 *et seq.*). The presence of starch in the medullary-ray cells in many plants at all times of the year suggests that the carbohydrates are fixed in these cells as starch. Solution by enzymes of this starch in response to an upward or a downward movement of the water in the tracheæ would provide a mechanism for the upward or downward transport of these substances in the transpiration stream.

It is hoped by experiments which are now in progress to throw some further light on this fundamental problem of plant physiology.

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Lunar Periodicity in Reproduction.

It is a common belief in many fish-markets around the Mediterranean and in other parts of the world that the amount of edible matter in sea-urchins and certain other invertebrates varies with the phases of the moon. The animals are said to be "full" when the moon is full and "empty" at new moon. This belief was recorded by Aristotle, Pliny, and other classical writers, and was stated by them to apply not only to sea-urchins, but also to oysters and other molluscs.

During the summers of 1920 and 1921 I made systematic examinations of the gonads of an Echinoid (*Diadema setasum*) at Suez with the object of testing the truth of the popular statement. I found the latter to be founded on fact to a surprising degree. There is a periodic reproductive cycle in this species of Echinoid which is correlated with the lunar period, the genital products being discharged into the sea at about each full moon during the breeding season. An examination of the testes and ovaries of a number of individuals between the first quarter and full moon shows the majority to be swollen and full of mature spermatozoa or eggs, while a lesser number are "spent," *i.e.* show evidence of having lately extruded their genital products. A week later the relative proportions are reversed. Some individuals have gonads still full of spermatozoa or eggs, but most are now "spent." Between the third quarter and the new moon all gonads are shrunken in size and contain nothing but developing spermatocytes or oocytes. From now onwards until the first quarter of the next moon these cells show progressive stages in development into spermatozoa and eggs which are to be spawned at about the time of full moon. This lunar cycle is repeated throughout the breeding season.

In seeking a causal connection between the reproductive rhythm and the lunar month an influence of the tides first suggests itself. But whereas there is a single reproductive cycle in each lunation, there are two spring and neap tidal periods, *i.e.* a double cycle. However, during the summer months at Suez the new moon spring tides have a greater range than those of the full moon, so that the maximum tidal range is attained only once during each lunar month. The higher and lower water at the new moon spring tides might conceivably react on the Echinoids by the different hydrostatic pressure (affecting, *e.g.*, the tension of dissolved gases) or by causing the animals to be at a greater or less distance than usual from the source of oxygen or of light. But the average excess tidal range at new moon spring tides over that at full moon spring tides during the period studied was only 58 cm. This small difference could scarcely affect the

urchins, for they are not sessile animals, but move actively, their vertical range of migration during the course of an hour being far in excess of this figure.

The possibility of tidal influence could be tested by keeping urchins in a floating cage. If the lunar reproductive cycle were thereby abolished, the tidal connection would be demonstrated; a contrary result from the experiment, however, would not dispose of a possible influence of the tides, for an established rhythm in a physiological process is often persistent after the original cause has been removed. Unfortunately the experiment was impracticable with Diadema owing to its size. Full-grown specimens measure more than one foot from tip to tip of the spines, and it was impossible to obtain large enough floating boxes to contain a hundred or more individuals. I intend, however, to seek further evidence regarding the possible effect of tides by studying Echinoids in localities with greater and smaller tidal ranges than at Suez. I am convinced, though, that if a similar lunar reproductive cycle exists in the sea-urchins at Naples or at Plymouth it is very little pronounced; for I have made use of the Echinoids at these places to obtain spermatozoa and ova for other experimental purposes for months on end without ever noticing a rhythmic variation in the condition or quantity of the genital products. At Suez the period in each lunar month when spermatozoa and eggs are unobtainable would necessarily force itself upon the notice of the investigator.

The possibility of a direct effect of the light of the moon on the Echinoids could be tested by keeping specimens in the dark. Although the large size of Diadema again precluded this experiment at Suez, I intend to carry it out in another place with a smaller Echinoid. If the light has an effect it must necessarily be more constant in the cloudless summer nights of Egypt than in Europe. It was thought possible that the light of the moon might act by causing the urchins to feed either more or less than usual on moonlit nights. A systematic examination of gut contents showed that this was not the case.

Other marine animals popularly believed in Egypt to vary with the moon are mussels and crabs. Contrary to the case of the sea-urchins, I have found these beliefs to be without foundation.

Now it is obvious that the periodic spawning of Diadema must be reflected in the plankton of the Gulf of Suez. The plutei must vary in quantity and in stage of development with the phases of the moon. By an examination of plankton from different parts of the world I hope to discover which of the animals having pelagic larvæ show a lunar reproductive cycle.

The best known example of lunar reproductive periodicity at the present time is the Palolo worm. In the South Pacific these Polychætes swarm at the surface of the sea to discharge their genital products at the third quarter of the October and November moon (Friedländer, *Biol. Centralbl.*, 1898–1901). In Japan another Palolo swarms at both full and new moon, *i.e.* at the spring tides (Izuka, Journ. Coll. Sci. Tokyo, 1903), while in the Atlantic a third species has similar habits (Mayer, Carnegie Inst. Pubs., 1909). Odontosyllis in Bermuda (Galloway and Welch, Tr. Am. Micr. Soc., 1911) and British Columbia (Potts, Proc. Camb. Phil. Soc., 1913), and Nereis (Lillie and Just, Biol. Bull., 1913) and Platynereis (Just, Biol. Bull., 1914) at Woods Hole, Massachusetts, have been shown to swarm at one definite phase of the moon, whereas Nereis at Naples (Hempelmann, *Zoologica*, 1911) swarms at about the first and third quarters. The latter bi-lunar, *i.e.* apparently tidal, periodicity is remarkable, since the tidal range at Naples is much smaller than at Woods Hole. Another Polychæte, Amphitrite, lays its eggs at new and full moon spring tides at Woods Hole (Scott, Biol. Bull., 1909), as does also the Turbellarian Convoluta in Brittany (Gamble and Keeble, Quart. Journ. Micr. Soc., 1903).

To my knowledge the only other case of reproductive periodicity in animals correlated with the lunar period is in the human race. Arrhenius (Skand. Arch. f. Physiol., 1898) showed statistically that there exists a low correlation between the menstrual period and the (tropical) lunar month. In addition, he found traces of a consequent tropical lunar periodicity in birth frequency.

The only authentic cases of lunar rhythm in the reproduction of plants seem to be among the algæ. In North Carolina Dictyota produces one crop of sexual products in each lunar month (Hoyt, *Bot. Gaz.*, 1907). The same plant at Naples (Lewis, *Bot. Gaz.*, 1910), and at Plymouth and Bangor (Williams, *Ann. Bot.*, 1905), has a tidal reproductive rhythm, *i.e.* two cycles per lunation, as is also the case with Sargassum (Tahara, *Bot. Mag.*, Tokyo, 1909).

Popular beliefs in the influence of the moon on plant growth are world-wide, although most of them are probably on a par with the superstition that a waxing moon increases and a waning moon decreases any process, such as the acquisition of wealth, the growth of corns, nails, hair, etc. In Egypt it is said that melons and other fruits of the Cucurbitaceæ grow most rapidly on moonlit nights. The belief that sowing and planting must be done in a waxing, and reaping and cutting in a waning, moon is very widespread. As regards cutting, experiments made recently in Trinidad by Rorer have proved the superstition to be without foundation. It is conceivable, nevertheless, that moonlight may have a photosynthetic effect. Kofoid (Bull. Ill. State Lab. of Nat. Hist., 1903 and 1908) and Allen (Univ. Cal. Pubs. Zool., 1920) have found a maximum frequency of plankton algæ in certain North American rivers occurring at full moon. Kofoid attributes this to lunar photosynthesis, quoting experiments of Knaute (*Biol. Centralbl.*, 1898) in support of his hypothesis. Owing to the great importance of this possibility, and since Knaute obtained a surprisingly large amount of photosynthesis in moonlight, I am at present repeating his work.

I should be grateful if readers of Nature would communicate to me popular beliefs in lunar influence on animals or plants. It is possible that some of them may prove upon investigation to be as well founded on fact as the case of Diadema.

H. Munro Fox.

School of Medicine, Cairo, January 25.

Research Degrees and the University of London.

There are at present four degrees in the faculty of science of the University of London which may be granted for a research thesis, namely, D.Sc., Ph.D., M.Sc., and (in exceptional cases only) B.Sc. If a recent report by a sub-committee of the Academic Council should be finally adopted by the University, these four will be reduced to two, D.Sc. and Ph.D., while a new series of examinations will be introduced for M.Sc. As I feel very strongly (with many of my geological colleagues) that this would be a mistaken policy, I venture to ask for space in the columns of Nature to state my reasons for that feeling.

It would scarcely be necessary to refer to the case of B.Sc. by research but for the serious misconceptions on the subject shown in the sub-committee's report. The granting of this degree is a very rare event, and I have no personal knowledge of any case

of its being granted, but I have always understood that it was reserved for the exceptional case of a serious scientific investigator whose academic career has been interrupted after the intermediate stage and who wishes to resume it at an age when the concentrated study necessary for the passing of the final B.Sc. examination cannot reasonably be required of him. If there is any reason to fear possible abuse of this means of graduating, it would be a simple matter to fix a minimum age-limit for it—say thirty-five—rather than to abolish it.

The immediate importance of the B.Sc. by research, however, is that it gives the sub-committee an opportunity to exaggerate the number of standards of research which examiners have to keep in their minds. The report says: "We do not consider it satisfactory that there should be as many as three, and still less four, degree standards of research." There is no fourth standard. I cannot conceive any examiner recommending the B.Sc. degree for a thesis which would be rejected for M.Sc. if offered by a graduate. On the contrary, I can easily imagine the University making it a rule to accept no thesis for B.Sc. which it would not accept for Ph.D., or even D.Sc., if this means of graduation is reserved for very exceptional cases. The conditions under which alone B.Sc. by research should be granted forbid the standard from making a fourth with the three standards of post-graduate research degrees. As to those three standards, as an examiner I have not found any difficulty in framing three standards in my own mind or in agreeing upon them with my colleagues. On the contrary, I find that the introduction of the Ph.D. degree has made it easier to define the standards of the two others. If the M.Sc. by research be abolished, the Ph.D. standard will inevitably tend to sink, until in a few years it will be equivalent to the present M.Sc.

I am certainly not speaking for myself alone when I express myself as strongly in favour of the retention of the M.Sc. by research; but if the University should decide to abolish it, I should very much prefer the abolition to be complete rather than that the degree should be granted by examination. The work of a candidate for M.Sc. by research must necessarily consist very largely (in some cases entirely) in a survey of the knowledge already acquired on the subject which he proposes to investigate. This involves the intensive study of original works of research possibly going far back into the early history of science and extending into various branches, all connected together by their bearing on some one problem. In geology, for instance, such an investigation may often include portions of the several branches—petrology, stratigraphy, palæontology, and economic geology.

A candidate studying for M.Sc. by examination will be engaged on very similar work, but its boundaries will be arbitrarily determined for him by the definition of some particular subject which he chooses from a published list. He will be warned off side-issues that may attract him by the fact that they will not form part of the subject-matter of his examination. He will be much more inclined to rely on text-books than on original papers, and any tendency to run down obscure questions for himself in the literature of the subject or by personal observation and research will be positively disadvantageous to him, since he will be discovering facts probably unknown to his examiners.

Examples could easily be found of able investigators whose life-work originated as a side-issue from an early line of study. At the beginning of post-graduate life a man cannot be expected to choose irrevocably his main line of work.

As an examiner I am convinced that the Honours B.Sc. stage is the highest at which examinations are of value, except as an altogether subordinate part of the qualifying test. After this stage every incentive should be given to the student to work on lines determined by his particular interests and opportunities, and not by what must be, even when every effort is made to avoid it, an arbitrary pigeon-hole sub-division of the sciences. A. MORLEY DAVIES.

Imperial College, S.W.7, February 9.

The Accuracy of Tide-predicting Machines.

I SHOULD like to make a few comments on Mr. Marmer's letter in NATURE of February 2, p. 136, as I was responsible for the tests made on the British machines referred to in your review of "British Research Work on Tides."

In his last paragraph Mr. Marmer states the various uses that can be made of tide-predicting machines in addition to their normal use. Most of these are quite likely to be well within the capacity of any machine, since relatively small quantities only are involved and the full scale of the machine can be used. But their use in "the elimination from the observed tide of the tide due to a number of constituents" is precisely that which was shown to be undesirable so far as the British machines were concerned. It has been found very advantageous in research work to subtract known constituents from the tidal record and to examine the residue, but for such work it is of prime importance to know that what we have actually removed is exactly what it professes to be. It is not desirable to spend time and energy on the examination of fictitious residues due to machine errors, and it was found that the British machines were subject to systematic errors of about 0·5 ft. in hourly heights (though not in heights of high and low water), with a spring range of 18 ft. Such errors entirely prohibited the use of these machines.

It is quite probable that the performance of the British machines can be improved, but the labour of reading the curves will be great. In this respect the U.S.A. machine has a notable advantage, and I should be very glad to know that one could obtain from it hourly heights with an accuracy suitable for research work, say to within 0·05 ft. for a spring range of 30 ft. But in fairness to the British machines, and not with a desire to impeach the working of the U.S.A. machine, I must say that I am not convinced by the tests recorded by Mr. Marmer. At Hong Kong the spring range of tide is only 4·5 ft., and if the full powers of the machine have been used, as is reasonable to suppose, then we should expect a *pro rata* error of 0·4 ft. with a spring range of 30 ft. It is fervently to be hoped that such is not the case, though I must confess that certain comparisons I have made between direct calculations and U.S.A. predictions show discrepancies of this magnitude, even in high- and low-water heights. Further, the difference in predictions between the U.S.A. machine and one of the British machines is much greater than is to be expected, if it be due to the errors only of the latter.

It is very noteworthy that the performance of the U.S.A. machine in 1922 agrees very well with its performance in 1910, indicating that its errors are truly systematic; but this is no consolation to a research worker unless he knows what the errors are. It is easy to see that the errors have not any obvious relationship to the actual tide predicted. The tests illustrate the difficulty one would have in dealing with the residues, for of the thirty constituents used about half are individually less than the error of the machine.

If only the largest constituents had been used the task of analysing for the remainder would have been made more onerous by the presence of this error, and much more so if there were unknown constituents to deal with.

I quite agree with Mr. Marmer that the only satisfactory method of testing the machines is to compare their results with the results of numerical or "hand" calculations, but such tests should be exhaustive and convincing. A. T. DOODSON.

Tidal Institute, University of Liverpool,
February 9.

The Brittleness of Ice at Low Temperatures.

SIR GEORGE BEILBY ("Aggregation and Flow of Solids," 1921) has recently directed attention to the impossibility of explaining the flow of glaciers at temperatures much below 0° C. on the regelation hypothesis, and the necessity for assuming a deformation of the ice-crystals by displacement along internal-glide planes or at the crystal boundaries. From his experiments on the behaviour of metals and minerals under pressure he suggests that in ice a vitreous modification will be produced at the plane of displacement, and that above a certain temperature—the "crystallisation temperature"—this will immediately revert to the crystalline state, the process being repeated indefinitely during movement. Should the temperature of the ice fall below this point it is predicted that the flow will be retarded, as the vitreous modifications of metals are harder than the crystalline, and their presence promotes rigidity.

It seems that here we have an explanation of the brittleness of ice at low temperatures. Navigators in the pack have noticed that the development of the pressure ridges is noiseless in summer, but accompanied by loud detonations in winter. Another consequence of the existence of this state at low temperatures is well known to every ski-runner in a distinct loss of gliding power. Sir George Beilby has shown that the "crystallisation temperature" for ice must lie somewhere below −12° C. There is general agreement in Norway that the "føre," though deteriorating slowly as the temperature falls below −5° C., receives a marked check at about −17° C., and Nansen's observations in the pack are fairly consistent with this figure. To test the validity of the explanation offered we must await the experimental determination of the "crystallisation temperature" of ice. L. HAWKES.

Bedford College, Regent's Park, N.W.,
February 4.

Age Incidence of Influenza.

WAS not the unusual age incidence of deaths in the influenza epidemic of 1918–19, referred to in NATURE of February 2, p. 130, due to the special circumstances of that time? With few exceptions, all civilians in this country at that date between the ages of twenty and thirty-five could have been placed in one of three classes:—

(1) Persons engaged in war-work on the land, in factories, offices, etc. All these were doing a full man's working day (judged by the standard of normal times), and many were seriously overworking.

(2) Ex-Service men discharged on account of ill-health.

(3) Mothers of young children, who in many cases went short of food themselves in order to ensure an increased ration for their families.

None of these would have been so resistant to infection, or so well able to throw off disease when contracted, as they would have been in normal times. ANNIE D. BETTS.

MISS BETTS suggests that the exceptional incidence of influenza mortality during the pandemic of 1918–19 may have been caused by the exceptional war-conditions, leading to the greatly increased occupation of women, to overwork of these and of men, and to the state of health of ex-Service men. To these suggested causes may be added the effect of the rationing of food, which might affect to an exceptional extent the mothers of young children.

These explanations of the strangely inverted age incidence of influenza mortality have been often debated. They cannot explain the course of events more than to a minor extent. For (1) with such an infectious disease as influenza domestic infection of older persons, even when they had escaped extra-domestic infection, must have been the general rule. War-conditions must surely have told heavily on aged persons.

(2) Curves given on p. 41 of the Registrar-General's Report on Influenza (Cmd. 700) show that this change in age incidence was unparalleled in the history of the disease, and that the changed age incidence characterised the beginning of each of the three consecutive waves of the disease. With the progress of each there was a diminishing youthfulness of decedents.

(3) This change in age incidence was not confined to this country or to other belligerent countries especially affected by war-conditions. It occurred, for instance, in Scandinavian countries and in America.

(4) The explanation that those attacked in the 1889–91 epidemic—the older section of the population—were relatively immune is not supported by any adequate body of evidence.

In short, the altered age incidence of influenza in the recent epidemic remains an unsolved problem. An easy way out of the difficulty, though a way probably not according with facts, would be to assert that the recent pandemic was a different disease from that of 1889–92. THE WRITER OF THE ARTICLE.

Dr. Frank Bottomley.

MAY I be permitted to make a correction of an error in Sir Richard Paget's obituary notice of my cousin, Dr. Frank Bottomley, in NATURE of February 16, p. 212? Sir Richard states that Frank Bottomley's stepmother was "the widowed sister of Lord Kelvin." Frank Bottomley's father, being a son of Lord Kelvin's sister Anna, could not possibly have married another of the sisters. Lord Kelvin had three sisters, namely, Elizabeth, widow of the Rev. David King (she never remarried); Anna, Mrs. William Bottomley, who was Frank Bottomley's grandmother; and Margaret, who died in early childhood. As a matter of fact, Frank Bottomley's stepmother was a sister of Lord Kelvin's second wife.

JAMES THOMSON.

22 Wentworth Place, Newcastle-upon-Tyne,
February 19.

Thermo-electric Instrument for Measuring Radiation from the Sky.

IN the note on Mr. W. H. Dines's memoir on "Observations of Radiation from the Sky" (NATURE, January 12, p. 54) you attribute to me the final design of the instrument. Permit me to say that Mr. Dines greatly elaborated and improved the thermo-electric instrument after I left it.

LEWIS F. RICHARDSON.

Westminster Training College,
Horseferry Road, S.W.1.

The Mechanism of Heredity.

By PROF. T. H. MORGAN, Columbia University, New York City, U.S.A.

I.

Mendel's Two Laws of Heredity and their Mechanism.

AT the time when Mendel discovered his two fundamental laws of heredity, no mechanism was known in plants or animals that would explain how such processes as those invoked by him could be brought about; but between 1865 and 1900 (when Mendel's "Principles" were recovered), the study of the ripening process (maturation) of the egg and sperm-cell had progressed so far that such a mechanism was ready at hand.

Mendel's first law—the law of segregation—may be illustrated by the following example: A tall edible pea crossed to a short pea gives tall (hybrid) offspring. These, if self-fertilised, produce on an average three talls to one short. Mendel pointed out that a very simple hypothesis will account for this ratio of 3 : 1 in the second generation (F_2). The original tall parent contributes one element (T), and the short parent another element (*t*) to the hybrid. If at the time when its germ-cells mature these elements separate (segregate), so that half the eggs come to contain the element for tallness (T), and the other half the element for shortness (*t*), and if a similar process takes place in the pollen of the hybrid (half the pollen grains bearing T and half *t*), then chance fertilisation of any egg by any pollen grain will be expected to give three kinds of individuals, namely TT, T*t*, *tt*, in the ratio of 1 : 2 : 1. The first two kinds (TT and T*t*) will be tall plants, because the one (TT) is pure for tallness, and because in the other (T*t*) tallness dominates shortness as seen in the hybrid. Hence the second generation will be made up of three talls to one short.

The unique feature of the situation, the segregation in the germ-cells of the hybrid of the elements derived from each parent, finds a parallel in the distribution of the maternal and paternal chromosomes of the hybrid. For example: every cell of the hybrid contains one chromosome (*a*) from one parent, and one chromosome (A, the mate of the former) from the other parent. But this condition is not permanent in its germ-cells, for when they arrive at the final ripening stage, the two chromosomes (*a*A) come together, conjugate, and then "segregate," *i.e.* they pass into opposite cells. As a result, half the eggs contain chromosome *a*, half chromosome A. They behave like Mendel's pair of "characters." Hence if the materials responsible for the difference between T and *t* are carried by the members of the same pair of chromosomes, A and *a*, they must follow Mendel's first law.

Mendel's second law applies to the independent behaviour of two or more pairs of characters: the members of each pair assorting independently of the members of other pairs. It has been generally supposed by cytologists that at the ripening of the germ-cells the members of the pairs of chromosomes separate independently, in the same way that Mendel supposed the individual pairs of characters to be distributed. Proof was difficult to obtain from direct observation, but recently this evidence has been abundantly and convincingly obtained by Miss Carothers. If then the chromosomes carry the materials (genes or differentials) for the hereditary characters, they behave in such a way as to ensure the success of Mendel's second law.

Had we only this parallelism to go upon we should be justified, I think, in accepting the chromosome theory of heredity as a working hypothesis, but further evidence has been steadily accumulating. It may be briefly summarised, yet

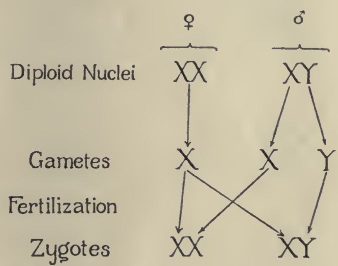


FIG. 1.

must be given in some detail; for it is the exact correspondence between fact and theory that furnishes the essential data for the conclusions arrived at.

(1) In some groups of animals it has been shown that one pair of chromosomes (XY) acts as a differential with respect to sex determination (Fig. 1). The female has two like chromosomes, called X and X; the male has one X, and often another chromosome called Y. Thus XX = ♀; XY = ♂. These chromosomes segregate at maturation, as do the others. Every egg eliminates one X in one of its polar bodies; half the sperms are X-bearing, half Y-bearing. Any egg (X) fertilised by an X-sperm = XX (♀); any egg (X) fertilised by a Y-sperm = XY (♂). Thus sex is here determined by a process that automatically gives equal numbers of males and females.

A son always gets his single X from his mother; a daughter gets one X from her mother, another from her father. Certain characters follow in their heredity the course taken by these chromosomes. For instance, if the mother is *aa*, and the father is A, each son will be *a*, each daughter will be *a*A.

Many examples of this sort could be given, and further tests of the different kinds of individuals that appear in such crosses could also be cited to show that the distribution of the sex-linked characters follows the distribution of the X-chromosomes. This evidence is so significant that it may be further illustrated by a concrete case. If a white-eyed female of the vinegar fly, *Drosophila melanogaster,* is bred to a red-eyed male (Fig. 2), the sons are white-eyed, and the daughters are red-eyed (red dominates white). If these are inbred there appear in the next generation white-eyed daughters, red-eyed daughters, white-eyed sons, and red-eyed sons in the ratio of 1 : 1 : 1 : 1.

The distribution of the X- and Y-chromosomes is illustrated by the rods in the middle of the diagram. The white rod stands for the X that carries the differential for recessive white eyes. The black rod stands for the X that carries the

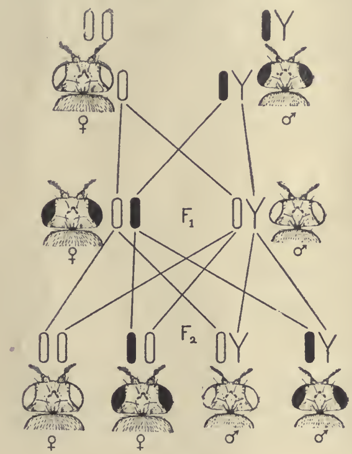


FIG. 2.

differential for dominant red eyes. The Y-chromosome is represented by that letter. It is obvious from the way in which these chromosomes are distributed that there should be both red-eyed and white-eyed grandchildren in equal numbers.

The reciprocal cross gives a different result (Fig. 3). Thus, when a white-eyed male is bred to a red-eyed female, both the sons and the daughters have red eyes. If these are inbred, there appear in the next generation red-eyed daughters, red-eyed sons, and white-eyed sons in the ratio of 2 : 1 : 1. Here also it is evident from the distribution of the X's why, in the second generation, the only white-eyed flies present are males. These carry a single white-producing X that traces back to the grandfather. All the granddaughters have red eyes, but are of two kinds, one pure for red, and the other carries both a red and a white rod. If these second-generation females are tested it is found, in fact, that half of them carry two red-producing chromosomes, and the other half a red and a white one. Evidence like this from sex-linked inheritance, where both the genetic and the chromosomal histories are known, furnishes by itself very strong evidence in favour of the chromosomal interpretation of heredity, but there is further evidence that makes the case even stronger. This evidence may now be briefly stated.

(2) Individual females of the fly Drosophila are

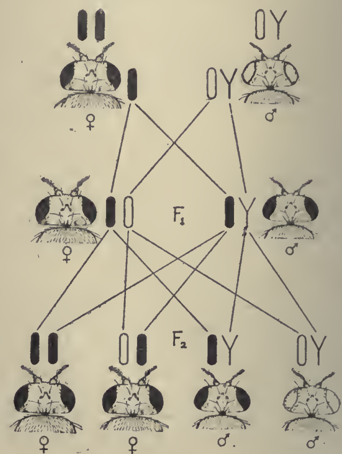


FIG. 3.

sometimes met with that break the rule for sex-linked inheritance. A genetic study by Bridges of this exceptional behaviour led to the prediction that they must have an extra sex-chromosome. Cytological examination showed, in fact, that there is in these females an X- and another X- and a Y-chromosome (Fig. 4). The genetic behaviour of the "non-disjunctional" females is so important for the chromosome theory that it must be followed through carefully. It will be simpler to give the genetic and the chromosome histories together.

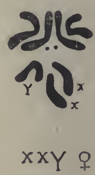


FIG. 4.

When an egg containing the three chromosomes XXY matures, the two X's may conjugate, leaving the Y free to go to either pole of the polar spindle (this happens in 92 per cent. of the cases), or else an X and the Y may conjugate, leaving the other X to go to either pole. As shown in the diagram (Fig. 5), four kinds of eggs result (and four kinds of polar bodies are extruded). If the non-disjunctional female in question has white eyes, the history of her white-bearing X's can be followed when she is fertilised by a male with a red-bearing X-chromosome. Considering first the fertilisation of her four kinds of eggs by the red-producing X-sperm of the male, it is evident that there will be produced four kinds of individuals, viz. XXY, XX, XXX, and XY.

Two of these red-eyed females are both hybrid for white; one of them should be a non-disjunctional female (XXY) and repeat the same process. Such

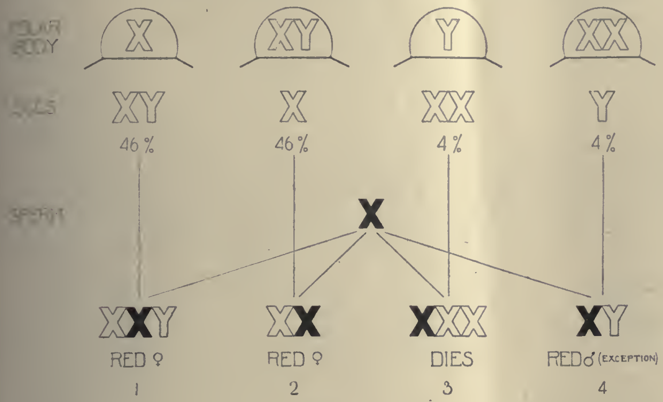
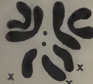


FIG. 5.

is the case. The females with three X's generally die, but occasionally one emerges that can be identified as such by certain peculiarities, and when the cells of such a female are studied it is found that three X's are present (Fig. 6). Lastly, there is a male, XY, with red eyes, an "exceptional male," since his mother had white eyes. He arises from a Y-egg fertilised by an X-bearing sperm—the so-called female-producing sperm. Here such a sperm makes a male because the combination of one X with the rest of the chromosomes is a male in these flies, quite irrespective of the origin of the X-chromosome. The result shows convincingly that the X-sperm normally gives rise to a female because it carries an X (the egg supplying another X), and not because its X is carried by a "female-producing" sperm.



XXX ♀

FIG. 6.

There remains to be considered the case where the same series of eggs is fertilised by the other kind of sperm, the Y-bearing sperm. In the lower line of Fig. 7 the outcome is shown. Two kinds of males appear, both white-eyed, but one XYY and the other XY. The latter, XY, is found to be a normal male; the former is expected, in some cases, to transmit both an X and a Y through his "female-producing" sperm and give rise in this way to non-disjunctional daughters (XXY). This, in fact, has been shown to occur.

The single class of females that appears in this series arises from the fertilisation of the XX-egg by a "male-producing" (Y) sperm. She has white eyes and "breaks the rule." She must, furthermore, from her origin, be herself a non-disjunctional female, and, in fact, has been shown to behave as such. Finally, the YY individual in the diagram is not found, and probably dies, as is to be expected, since it contains no X-chromosomes.

(3) From an entirely different source new proof of the chromosome theory has been found. This, too, involves the sex-chromosomes. We have a stock that gives results diametrically opposite to ordinary sex-linked inheritance. The females

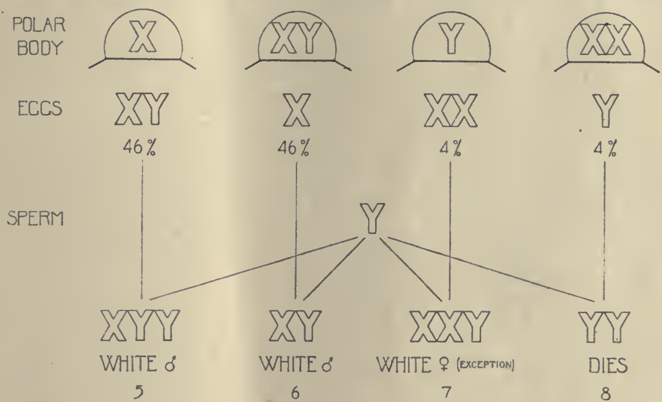


FIG. 7.

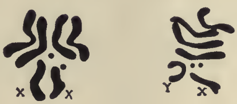
are yellow (recessive), and give, when bred to a normal grey male, yellow daughters and grey sons. A study of this stock by L. V. Morgan, who discovered it, showed that all the results could be explained by the assumption that two X-chromosomes, bearing yellow, had become stuck together. Sections of these females verified the prediction. Two united X-chromosomes and a Y are present in the yellow females (Fig. 8). At maturation of the eggs both X's pass out together into the polar body at the reduction division, or else both remain in the egg. Thus the mature eggs are XX or Y. Fertilised by a normal "grey" X-sperm, the XX egg gives an XXX grey female (which dies as a rule) and an XY

grey male. Fertilised by a Y-sperm, the two kinds of eggs give XXY yellow females and YY individuals (which die). Thus, of the four kinds of individuals expected, half the females (XXX) and half the males (YY) die, and a sex ratio of 1 : 1 remains. It has been stated above that XXX females appear at rare intervals. These are grey and are recognisable as XXX individuals by certain stigmata, and have been shown in sections to possess the three X's.

(4) Drosophila, and presumably other animals belonging to the XX–XY type, are so constituted that they can develop with one X or with two X's, provided the other chromosomes are present in duplex. In short, sex determination has been

FIG. 8.

regulated along these lines. Failure to obtain similar situations in the case of the other chromosomes led us to suppose that an individual lacking one or both members of a pair could not "come through"; but we had no actual proof that this was the explanation of their absence. Nevertheless, it was anticipated that it might be possible for individuals lacking one or containing three of the very tiny IV-chromosomes (Fig. 9) to survive. Recently Bridges has found such individuals, and we now realise that they must have been rather frequently met with in the past, but were not recognised as such. A fly with only one of the IV-chromosomes is small, pale, hatches late, has small, slender bristles and a dark trident. The



XX ♀ XY ♂

FIG. 9.

wings are blunt and slightly spread, and the eyes large and roundish. If a female, it is expected to contain two kinds of mature eggs (*i.e.* eggs after the polar body has been extruded)—one kind with, the other kind without, a IV-chromosome. The egg with one IV-chromosome gives a normal result when fertilised. The egg without a IV-chromosome, if fertilised by a sperm carrying a recessive IV-chromosome character, produces an individual (♂ or ♀) showing the recessive character of the father, because the single IV-chromosome of this individual came from the father that carried the recessive in question. A male that has only one IV-chromosome in its cells produces two kinds of sperm, one with IV and one without IV. Mated to a normal female, the results are in principle the same as above. A male and a female, each with only one IV-chromosome, when mated, might be expected to give some individuals (25 per cent.) without a IV. None such appear, and the ratios show that they die.

Individuals with three IV's are also known. Their characteristics are the opposites of those shown by the haplo-IV's. For example, they are dark with a very faint trident, long-bristled, and have small, smooth eyes. Their wings are long and narrow. Females of this kind produce two kinds of eggs, one kind with two IV's, the other kind with one IV. Mated to a normal male, with a IV-chromosome recessive character, such females produce daughters and sons of two kinds, namely, one kind with three IV's, like the mother, and the other kind normal.

If these males and females, triploid for IV, are mated, the recessive character appears in only 4 per cent. instead of the Mendelian 25 per cent. of the offspring, as would be expected when one recessive and two dominant characters are involved.

Many combinations between triploids and haploids are possible, and unique ratios are expected. These have also been worked out. Cytological preparations of triplo- and haplo-IV's show in

FIG. 10.

one case three small chromosomes, and in the other only one.

(5) Complete triploid individuals having three of each kind of chromosome have recently been found by Bridges (Fig. 10). The triploid flies are larger and coarser than normals, and also have large, rough eyes. Their eggs, as shown by genetic tests, contain all possible combinations of chromosomes, behaving as though non-disjunction takes place independently in each set of three.

Amongst the offspring of a triploid female (mated to a normal male) there is one class that has three II's, three III's, and three IV's, but with two X-chromosomes. This individual is an intersex, more like a male than a female. There is another class that has three II's, three III's, but only two IV's. It also is an intersex, but more like a female.

Thus sex itself, in this animal, is shown to be an expression of a balance between the X-chromosomes and the rest of the chromosomes. The results show that the differentials which determine sex are not confined to the sex-chromosomes alone. Some appear to be in the II- and III-chromosomes, and others in the IV-chromosome.

(*To be continued.*)

Obituary.

PROF. GIACOMO CIAMICIAN.

BY the death of Prof. Giacomo Luigi Ciamician, of the University of Bologna, Senator of the Kingdom of Italy, which occurred on January 2 of the present year, Italy has lost one of her most distinguished men of science, and modern chemistry one of the most assiduous and most successful of its cultivators.

Ciamician's work was characterised by the breadth and originality of its grasp. It ranged practically over every department of the science—spectrum analysis, electrolytic dissociation, organic synthesis by plants, chemical action of light, spatial chemistry—but it was mainly concerned with problems of organic chemistry, and it is by his labours in certain special fields of this branch that he will be chiefly remembered. One of his earliest investigations was an inquiry into the chemical nature and constitution of the resins and gum-resins—a confessedly difficult and complicated subject forty-five years ago when he first attacked it. By distilling abietic acid, the main constituent of colophony or ordinary rosin, with zinc-dust in a current of hydrogen—a reduction-process which had been already proved to be of general utility—he obtained a number of aromatic derivatives, notably toluene, *m*-ethylmethylbenzene, naphthalene, methylnaphthalene, and methylanthracene. Gum-benzoin similarly treated yielded similar products, together with small quantities of xylene. Elemi-resin also yielded toluene, and ethylmethylbenzene and ethylnaphthalene, but no naphthalene or methylanthracene. Gum-ammoniacum gave both para- and meta-xylenes and meta-ethylmethylbenzene, and the methylether of ortho-ethylphenol, but no naphthalene derivatives. These observations are of considerable interest, but they do not necessarily throw light upon the constitution of the terpene-resins, as certain of the products may be the result of secondary reactions. In fact, aldehyde-resin, obtained from ordinary aldehyde and therefore not an aromatic derivative, on reduction with zinc-dust, was found to yield ethylbenzene, meta- and para-ethyl toluene, and methylnaphthalene.

In 1881 Ciamician attacked the chemistry of pyrrole, a constituent of the fetid-smelling product obtained by heating bones in the preparation of animal charcoal, and hence termed bone-oil or Dippel's oil, from the name of the chemist who, so far back as 1711, first attempted to get an insight into its nature. This product has been known for at least four centuries, and has been the subject of repeated inquiry.

The investigation of pyrrole, first isolated by Runge in 1834, its congeners and derivatives, occupied Ciamician, at intervals, for upwards of a quarter of a century, and he published, partly alone, and partly in conjunction with Dennstedt, Weidel, Anderlini, Magnaghi, Magnanini, Silber, and Zanetti, no fewer than sixty communications on its chemistry. In 1904 he reviewed all this work in a lecture delivered to the German Chemical Society, afterwards printed in vol. 37 of its Berichte. It forms a remarkable chapter in the development of a section of organic chemistry with which Ciamician's name will always be associated He established the nature of pyrrole as a secondary amine, its carbon and hydrogen atoms forming a closed chain, the hydrogen atoms being symmetrically situated with respect to the carbon atoms, as suggested by Baeyer. Its formation from succinimide by distillation with zinc-dust, and the fact that it yields succinaldehyde dioxime by the action of hydroxylamine, conclusively established this view of its constitution.

Ciamician's work on pyrrole had many side issues. He elucidated its relations, not only to the substances with which it is associated in bone-oil, such as pyridine, into which he showed it might be converted, but also to indole and indigo. He was naturally led to the study of the products of the destructive distillation of gelatin, and, with Weidel, discovered pyrocoll, which he regarded as a quinone of the constitution

$$C_4H_3N\langle{}^{CO}_{CO}\rangle C_4H_3N,$$

or as the anhydride of carbopyrrolic acid, of which, with Silber, he prepared a number of derivatives, and eventually effected its synthesis by heating a solution of carbopyrrolic acid in acetic anhydride, when pyrocoll, with all the properties of that obtained from gelatin, sublimes.

Pyrrole derivatives are concerned in vital processes. They have been found in plants, and certain of them have been shown by Willstätter to exist among the decomposition products of chlorophyll and of hæmoglobin—one more illustration of the remarkable analogies which exist between these substances so important in their physiological functions.

Ciamician was early attracted to plant chemistry, and made important contributions to our knowledge of the nature and constitution of substances produced by photosynthetic processes in the vegetable organism. He determined the constitution of apiole, a substance found by von Gerichten in parsley seeds, and of the analogous compounds safrole, the chief constituent of the essential oil of sassafras and found in other natural oils, leaves, and fruits, and eugenol, a still more widely distributed natural product. With Silber he investigated the constituents of coto- and paracoto-bark, substances of pharmacological interest, and derived from plants growing in Bolivia and Venezuela.

A growing plant is a living laboratory in which synthetic processes may be directed, controlled, or modified, as in the human organism, by external means. In conjunction with Ravenna, Ciamician studied the effect of the introduction of various natural organic products into plants, with the view of determining their fate, or their influence on the life-history or development of the plant. They showed that plants will tolerate and utilise glucosides, such

as amygdalin, salicin, and arbutin, but will quickly die when the aromatic constituents of these glucosides are separately introduced. They found that plants are capable of transforming saligenin, benzyl alcohol, and vanillin into glucosides, saligenin, for example, being converted into salicin. They studied the effect of the inoculation of pyridine, piperidine, and pyrrole derivatives on the formation of alkaloids; they found that the amount of nicotine in the tobacco plant could be considerably increased by the introduction of dextrose. Their results lent support to the view that vegetable alkaloids have their origin in amino-acids, and that bases, such as lysine and ornithine, formed from amino-acids, are utilised by plants in the synthesis of alkaloids.

The chemical action of light has long been a special study with Italian chemists. Blessed with sunnier skies than we enjoy in these latitudes, they have had ampler opportunities than we possess to observe its effects, and, thanks to their long-continued and systematic work, a considerable body of information has been accumulated. Some of Ciamician's earliest observations had reference to this subject, and it continued to interest him to the end of his days. He noticed the conversion under its influence of quinone into quinol; of an alcoholic solution of nitrobenzene into aldehyde, aniline, and quinaldine; and of *a*-nitrobenzaldehyde into *o*-nitrosobenzoic acid, the nature of the changes and the character of the products formed being affected by the vehicle in which the substances under examination were contained, and the refrangibility of the light-rays. Unsaturated compounds tended to polymerise. An aqueous solution of acetone yielded acetic acid and methane; maleic acid was converted into fumaric acid; vanillin, piperonal, salicylaldehyde, and cinnamaldehyde yield the corresponding acids; lævulic acid forms propionic acid; many cyclo-ketones are broken down and fatty acids and aldehydes formed; benzaldehyde is resinified, and may be condensed with many different compounds; solutions of benzophenone in aromatic hydrocarbons yield benzopinacone, and the hydrocarbon undergoes condensation; camphor in dilute aqueous alcoholic solution yields acetaldehyde and campholenaldehyde; fenchone forms carbon monoxide and fenchone hydrate. Aromatic hydrocarbons in presence of water and oxygen are partly oxidised to the corresponding carboxylic acids. Pyrrole by prolonged exposure is completely decomposed, one of the products being succinimide, which may be regarded as the ketonic form of the quinol of pyrrole.

This is but a bald and imperfect summary of an intensely interesting and most important chain of observations, the full significance of which is scarcely yet realised. The potency of light has, of course, long been recognised, but no such evidence of its power to induce chemical action had hitherto been adduced as that afforded by Ciamician's work.

Ciamician was an accomplished, well-informed man, of great personal charm, whose influence on the chemistry of his epoch will long be felt. His merits were widely recognised. He was a foreign associate of the French Academy and an honorary fellow, since 1911, of our Chemical Society. He was an occasional visitor to London, and personally known to some British chemists who will long cherish his memory as an earnest and single-minded follower of the science he has done so much to enlarge and adorn. T. E. THORPE.

WE regret to see the announcement of the death on Saturday, February 18, of SIR JOHN MCCLURE, who for the past thirty years has been headmaster of Mill Hill School. Sir John McClure, who was born in 1860, received his education at Cambridge, where he took mathematics and law. From 1885–91 he acted as lecturer in astronomy and other scientific subjects under the Cambridge University Extension Syndicate, while from 1888–94 he was professor of astronomy at Queen's College, London. It was in 1891 that he received the appointment of headmaster at Mill Hill School, a post which he filled with conspicuous success for more than thirty years. The school, which was founded in 1807 for the education of Nonconformists when the older universities were not open to them, was reconstituted in 1869, and flourished for a time; but when Sir John McClure arrived in 1891 there were only sixty-one boys. He immediately set to work to develop and reconstruct the school, with the result that last year he was able to announce that the number of boys under his charge had grown to 361. Sir John McClure was also active in the cause of education outside his school. From 1904–13 he was honorary secretary of the Incorporated Association of Headmasters, and later became president, and it was mainly in recognition of these and similar services to education that he received the honour of knighthood in 1913.

ORIENTAL learning has suffered a grievous loss by the death, at the age of eighty years, of SIR ARTHUR NAYLOR WOLLASTON, K.C.I.E. Appointed to a post in the India Office at the age of sixteen, Wollaston served for forty-eight years in that Department. In 1898 he succeeded the late Mr. F. C. Danvers as registrar, and he was so successful in arranging the voluminous series of records that they became readily accessible to students. In this task he was succeeded by his pupil, Mr. W. Foster, who has done valuable work in calendaring the collection. Wollaston, in addition to his official duties, became an admirable Persian scholar, though he never had the good fortune to visit the East. He translated the Fables of Bidpai, and edited Sir Lewis Pelly's "Miracle Play of Hasan and Husain." But the work by which he will be best remembered is his great English–Persian Dictionary. At Walmer, where he resided for many years, he took an active share in the local administration.

THE death is announced of PROF. ERICH EBLER, professor of inorganic and analytical chemistry in the newly founded University of Frankfort-on-Main. Prof. Ebler, who was forty-two years of age, was appointed only in 1920, after service with the Army in the field.

Current Topics and Events.

We are glad to be able to announce that representatives of British science are included among those who have received their Majesties' invitation to the marriage of Her Royal Highness Princess Mary on Tuesday next, February 28.

Prof. F. G. Hopkins and Dr. W. H. R. Rivers have been elected members of the Athenæum Club under the rule which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

In a letter to Nature of May 19, 1921 (vol. 107, p. 359), Prof. Stanley Gardiner directed attention to the serious effect of the German Reparations (Recovery) Act upon scientific workers and institutions in this country in regard to the duty of 26 per cent. on German publications; Prof. Gardiner at the same time protested strenuously to the Board of Trade. He has now received a reply in which the Board states that an Order has been made under section 5 of the Act referred to granting exemption from the levy in the case of certain periodical publications in the German language. The Order, which is dated February 16, reads:—"Any article of the following description shall be exempt from the provisions of the said Act—that is to say, any article being a publication in the German language which is proved to the satisfaction of the Commissioners of Customs and Excise to be a periodical publication of a German learned society or other scientific or philosophical periodical publication." Communication should be made with the Secretary, Custom House, Lower Thames Street, E.C.3, for particulars as to the manner in which to apply for the exemption of any particular consignment.

The relatives of the late Sir Ernest Shackleton decided that the most appropriate burial-place for the dead explorer was the sub-Antarctic island of South Georgia, where he died and on which he performed the great feat of crossing the unknown ridge of mountains on his way from Elephant Island to the settlement of whalers in 1916. The body, which had been brought from South Georgia to Monte Video by Capt. Hussey, the meteorologist to the Shackleton-Rowett Expedition, was accordingly conveyed on board the British whaler *Woodville* at that port on February 15, the late explorer's birthday, and Capt. Hussey sailed with his old leader on the following morning. The Uruguayan Government, with characteristic sympathy and generosity, arranged the funeral procession as a State function, particulars of which appeared in the *Times* of February 16. The body in the rough wooden coffin made by the South Georgian whalers was taken to the English church in Monte Video, where the funeral service was read by Canon Blount. The coffin, placed on a gun-carriage and covered with the Union Jack and many wreaths, including one in bronze from the Uruguayan Government, was taken to the British Club, the British Chargé d'Affaires and many members of the British colony, including some from Buenos Aires, following. At the club the Uruguayan Minister of Foreign Affairs joined the procession, which moved on to the wharf accompanied by a guard of honour of Uruguayan Lancers, and the streets were lined with troops. At the wharf the Uruguayan War Minister delivered a sympathetic address, which was replied to by the British Chargé d'Affaires. When the *Woodville* sailed she was accompanied to the limit of territorial waters by the Uruguayan cruiser *Uruguay*, and on parting she fired a salute and ranged alongside the *Woodville*, with all hands lining the ship in farewell. The burial will take place on March 1, and a memorial service will be held in St. Paul's Cathedral on March 2.

A somewhat startling paragraph recently appeared in the *Times* giving an account of petroleum "divining" of an extraordinary nature by means of laboratory experiments carried out in France. Dr. Henri Moineau and M. Regis have apparently been at work on an apparatus for which it is claimed that by "harnessing Hertzian waves" the composition of subterranean solid, liquid, and gaseous matter may be indicated, quite irrespective of distance! Experiments are at present being carried out at the Puy du Dôme, in the Clermont-Ferrand region, and already this mysterious apparatus has detected petroleum deposits in Alsace, Saxony, Hanover, Czecho-Slovakia, Italy, the Rocky Mountains, the Allegheny Mountains, and finally in the Andes. No account whatever is given of the nature of the apparatus itself, though it is suggested that X-ray photography plays an important *rôle* in the determinations, particularly in the elucidation of underground structures. It is further alleged that with the apparatus it is possible to discern, not only oil, but also coal, minerals, and water occurring in remote parts of the world, the idea being that once such occurrences are located all that is necessary as a preliminary to successful boring is an aerial reconnaissance for the purpose of taking "X-ray photographs" of the selected areas. We cannot refrain from remarking that, although first impulse may dictate a dismissal of the matter as extravagant, present knowledge of electromagnetic wave propagation, though limited, is sufficient to promote realisation of possibilities, and caution before condemning prematurely their utilisation in the present connection.

At a celebration which took place in the chemistry lecture theatre of the Sorbonne on January 22 Prof. Henry Le Chatelier was presented with a gold medal in commemoration of his fifty years' work of scientific and technical research. The chair was occupied by M. G. Noblemaire, president of the Comité Jubilaire, who recalled the various stages in the career of the illustrious *savant* and outlined the series of remarkable discoveries made by him, most of which have received important industrial applications. Eloquent speeches were also made by M. Molliard, dean of the Faculté des Sciences, and by M. Bertin, president of the

Académie des Sciences. Prof. Trasenster, representing the University of Liège, handed Prof. Le Chatelier the diploma of engineer *honoris causa* of the "Faculté Technique Wallonne." Surrounded by eminent men of science, engineers, and students, Prof. Le Chatelier, after thanking the members of the committee, declared that he was happy "to have been able to add a few links to the solid and durable chain of scientific discoveries, science being essentially a collective work, forged by the continuous and methodical labour of the *savants.*"

THE search for the two missing men, Tessem and Knudsen, of Amundsen's Arctic Expedition who left the *Maud* in October, 1918, in the vicinity of Cape Chelyuskin carrying dispatches to Europe leaves no room for hope that they are alive. The *Times* of February 18 announces that Capt. Jacobsen, who has been searching the north-west coast of Siberia in the *Heimen*, found a note from the men near Cape Wild (long. 91° 30′ E.) to the effect that they arrived there in the middle of November, 1918, and found their provision depôt much damaged by sea-water, but that they were leaving under favourable conditions for Port Dickson, at the Yenisei mouth. Beyond Cape Wild, at a distance which Capt. Jacobsen does not specify, he found the remains of camp-fires and indications that a human body had been cremated. He believes that one of the men died there and that the survivor burnt his body lest it should be devoured by bears. No further traces were found.

THE first volume of the Dictionary of Applied Physics, of which Sir Richard Glazebrook is the editor, is announced by Messrs. Macmillan and Co., Ltd., for March, and the remaining four volumes may be expected before the end of the year. The successive volumes are to be devoted to mechanics, engineering, and heat; electricity; meteorology and metrology; optics, sound, and radiology; and metallurgy and aeronautics. The arrangement of the articles in all the volumes is to be alphabetical, and each article is written by a specialist. The list of contributors shows that the editor has succeeded in securing actual workers in each branch, and that the articles will therefore be thoroughly up to date. As the first attempt to place before the public in a convenient form the methods and results of recent research in applied physics, the Dictionary will be welcomed by all engaged in industries in which physics plays a part, as well as by scientific workers generally.

THE annual dinner of the Illuminating Engineering Society on February 10 aptly illustrated the variety of work with which the society is now concerned. Sir John H. Parsons, president of the society, presided. Sir Herbert Jackson, representing the Royal Society, proposed the toast of "The Illuminating Engineering Society," and Mr. J. B. Lawford (chairman of the Council of British Ophthalmologists) joined him in expressing appreciation of the programme of the society, notably in promoting discussion of the effect of light on the eye. The toast of "Kindred Societies" was proposed by Mr. F. W. Goodenough. Mr. T. Hardie (president of the Institution of Gas Engineers) and Mr. A. A. Campbell Swinton (vice-president of the Institution of Electrical Engineers and chairman of the Royal Society of Arts) pointed out how those associated with both forms of lighting had found a common interest in illuminating engineering. The toast of "The Guests" was proposed by Mr. L. Gaster. Mr. R. E. Graves (H.M. Chief Inspector of Factories) and Mr. William Brace (Mines Department), in responding, referred to the activities of the society in connection with industrial lighting and conditions of illumination in mines, and Mr. H. E. Blain emphasised the importance of good illumination in the interests of safety, both in relation to traffic and in industry.

THROUGH the generosity of the Fertilisers Manufacturers' Association and of the British Sulphate of Ammonia Federation, a special member has been appointed on the staff of the Rothamsted Experimental Station for the purpose of explaining the plots to farmers and others. Mr. H. V. Garner, of the School of Agriculture, Cambridge, has accepted the new post. The director, Dr. E. J. Russell, will now be glad, therefore, to arrange with secretaries of farmers' clubs, Chambers of Agriculture, and other bodies interested for visits to the plots. Among important items of interest are experiments on the manuring of arable crops, especially wheat, barley, mangolds, and potatoes; the manuring of meadow hay; the effect of modern slags and mineral phosphates on grazing land, hay land, and arable crops; crop diseases and pests; and demonstrations of good types of tillage implements, tractors, etc. At any convenient time between May 1 and October 1 there is sufficient to occupy a full day, and provision is being completed for assuring that the time shall not be lost, even if the weather turns out to be too bad to allow of close inspection of the fields.

IT will be remembered that Dr. Saleeby, writing in NATURE of December 8, p. 466, urged the importance of a co-ordinated inquiry into the action of sunlight in health and disease, under the auspices of the Medical Research Council. We are glad to see that the council has now appointed the following Committee to report upon the promotion of researches into the biological action of light with the view of obtaining increased knowledge of the effects of sunlight and other forms of light upon the human body in health or disease:—Prof. W. M. Bayliss (chairman), Mr. J. E. Barnard, Dr. H. H. Dale, Capt. S. R. Douglas, Sir Henry Gauvain, Dr. Leonard Hill, and Dr. J. H. Sequeira. Dr. Edgar Schuster is secretary of the Committee.

AT the monthly meeting of the Zoological Society of London held on February 15 twenty-four new fellows were elected to the society and thirty proposed for the fellowship. The secretary stated that the additions to the society's menagerie during January numbered 151—52 by presentation, 76 deposited, and 23 by purchase. The most important accessions included a Macedonian wolf (*Canis lupus*), a Dybowski's deer (*Cervus hortulorum*), eleven plumbeus quails (*Synaecus plumbeus*), and two angle

fish (*Pterophyllium scalare*), the last two species new to the collections. The report of the secretary recorded a considerable decrease in the number of visitors to the gardens in January as compared with the numbers of the corresponding month last year.

AT a meeting of the council of the National Institute of Agricultural Botany held on February 9 the first election of fellows of the institute took place. A hundred and ten candidates were elected, among whom were the following:—H.R.H. the Duke of York, the Prime Minister, the Duke of Bedford, the Marquess of Crewe, the Earl of Ancaster, the Earl of Derby, the Earl of Crawford, Viscount Milner, Lord Clinton, Lord Bledisloe, Lord Ernle, Sir Gilbert Greenall, Sir Harry Verney, Sir Matthew Wallace, the Hon. E. G. Strutt, the Right Hon. E. C. Pretyman, M.P., the Right Hon. Sir A. Griffith-Boscawen, Sir Thomas Middleton, Mr. Charles Adeane, Mr. Samuel Farmer, Mr. R. R. Robbins, and Lady Margaret Boscawen.

THE officers and other members of council of the Malacological Society of London for the ensuing year were elected on February 10 as follows:—*President:* Mr. A. S. Kennard. *Vice-Presidents:* Mr. J. R. le B. Tomlin, Prof. A. E. Boycott, Mr. G. K. Gude, and Mr. C. Oldham. *Treasurer:* Mr. R. Bullen Newton. *Editor:* Mr. B. B. Woodward. *Secretary:* Mr. A. E. Salisbury. *Other Members of Council:* Dr. A. H. Cooke, Mr. H. O. N. Shaw, Lt.-Col. A. J. Peile, Mr. T. Iredale, Dr. E. W. Bowell, and Mr. Hugh Watson.

ON Thursday next, March 2, Prof. H. M. Lefroy will deliver the first of two lectures at the Royal Institution on (1) "The Menace of the Insect Pest" and (2) "The Balance of Life in Relation to Insect Pest Control." On Saturday, March 4, Sir Ernest Rutherford will begin a course of six lectures on radioactivity. The Friday evening discourse on March 3 will be delivered by Dr. C. Morley Wenyon on "Microscopic Parasites and their Carriers."

DR. W. BATESON, director of the John Innes Horticultural Institution, Mostyn Road, Merton, S.W.19, is giving a demonstration of the genetics of *Primula sinensis* at the institution to-day, February 23, at 3 p.m. All interested in the subject are invited, and in particular those who attended Dr. Bateson's lectures on genetics in November last. Admission is free, without ticket.

THE ninth election to Beit fellowships for scientific research will take place in July next. Applications must be received by the Rector, Imperial College of Science and Technology, South Kensington, S.W.7, not later than April 19. Forms of application and all information respecting the fellowships are obtainable from the Rector of the Imperial College of Science and Technology upon written request.

THE first award of the Meldola medal, referred to in NATURE of January 12, p. 49, has been made by the council of the Institute of Chemistry, with the concurrence of Dr. Percy E. Spielmann, representing the Maccabæans, to Dr. Christopher Kelk Ingold.

Our Astronomical Column.

DETONATING FIREBALL IN SUNSHINE.—Mr. W. F. Denning writes that this object observed by him on February 7 at 3.55 p.m. appears to have been seen by comparatively few observers, although the loud detonations which followed it were heard by large numbers of people, chiefly in Warwickshire, over which county the fireball passed. It seems to have caused the loudest reports near the middle section of its flight, in the region of Quinton, Feckenham, Mere Hall, and Droitwich. At some places there was only one sound heard, at others two, but all the observers agree that the concussion and vibration were of startling intensity. The detonations were heard along a line directed from S.E. to N.W. The radiant point of the meteor was at $60° - 11°$, and the height from 56 to 32 miles; the length of luminous flight was 82 miles, and velocity about 10 miles per second. The position of the object was from over Oxfordshire to Shropshire.

MOVEMENTS IN SPIRAL NEBULÆ.—In this column for January 12 reference was made to the movements in spiral nebulæ which Dr. Jeans described at the Royal Astronomical Society when exhibiting slides sent by Dr. van Maanen. Dr. van Maanen has now published the fifth paper on this subject in the issue of the *Astrophysical Journal* for December last, showing the results of his investigation with regard to the spiral nebula Messier 81. This paper contains the evidence on internal motions derived from the four nebulæ which Dr. van Maanen has now measured, namely, M 101, 33, 51, and 81, and he summarises the results in a table of which the following is an abstract. The second column gives the interval in years between pairs of photographs he has compared, and the following four columns the motions as indicated at the heads of the columns. The last column gives the number of nebular points the positions of which were independently measured:—

(*Units for Motions* 0·001″.)

Object	Interval in years	Rotational	Radial	Stream	Transverse	No. of nebular points
M 101	5	+21	+ 5	+21	0	87
M 101	9	+20	+ 6	+22	− 3	69
M 101	15	+12	+ 7	+14	+ 2	46
M 33	10	+20	+ 6	+24	− 2	30
M 33	5	+14	+12	+18	+ 4	21
M 51	11	+19	+ 8	+21	+ 3	79
M 81	6	+20	+17	+25	+16	52
M 81	11	+38	+13	+39	+ 7	104

It will be seen that all pairs of plates show the same type of motion, and, as Dr. van Maanen points out, the agreement in the values of the motion for each nebula derived from different pairs of plates is as satisfactory as could be expected. In addition to the rotational components, which correspond to the periods in the order of the nebulæ in the table, namely, 85,000, 160,000, 45,000 and 58,000 years, they all show a large outward radial component. The close agreement of the displacements in direction with the spiral arms of the nebulæ suggests, as he states, "a realisation of the motions described by Jeans in 'Problems of Cosmogony and Stellar Dynamics.'"

Research Items.

Juvenile Delinquency.—In *Psyche* (vol. 2, No. 3) Dr. Cyril Burt discusses the causes and treatment of juvenile delinquency. In studying crime, he points out, we encounter at the outset the fact of multiple determination. Crime in any given person usually proves to be attributable, not to some one all-explaining cause such as "inborn criminality," but to a converging number of alternating factors. Usually some predominating factor can be singled out as chiefly responsible, which factor may be a legitimate label for classification, but in treatment it is never safe to deal with one factor only, however crucial it may be. In all cases it is necessary, for any scientific appreciation of the disturbance, to make a complete and comprehensive survey of the whole child and his surroundings; we must know the child's physical characteristics as well as its emotional and intellectual endowment. The author, while assigning a due position to mental defectiveness, does not support the view that all or most criminals are mentally defective. Various methods of diagnosis and of treatment are discussed. The article will be extremely valuable to all those who, whether from the point of view of theoretical psychology or of practical life, are interested in the individual and social consequences of delinquency.

Craniometry in the British Isles.—Prof. F. G. Parsons has done good service to anthropometry by collecting in the February issue of *Man* all the available records of the cephalic index to be found in these islands. The record of 3000 criminals is of special interest, as they show the very high cephalic index of 785, and the size of their heads is very low. This suggests that our recent immigrants from Central Europe have contributed even more than their fair share of crime. It is also remarkable that the average index of a group of Cambridge students is 796 as compared with the Oxford average of 780; possibly some mistake has crept into the arithmetic, but the question deserves further investigation. Other interesting deductions from these figures are that the average head-shape of people in England differed very little between Saxon times and the eighteenth century, the trifling variations being probably due to immigration from the Continent; and that these records do not supply any reason to believe that the size of the modern Englishman's head is increasing with its increasing rotundity; in fact, both the Saxons and the Long Barrow folk, from the fusion of whom most of our blood is derived, seem to have had rather larger heads than the average modern Englishman, and there is no reason to believe that physically they were larger men. Unfortunately, these records, confined to the cephalic index, take no account of head height, which is a serious loss. Further, this collection, large as it is, is inconclusive when compared with a population of some forty millions. In the past, as, for instance, in India, the evidence from craniometry has led to unfounded theories because the number of the subjects was insignificant as compared with the total population. If it is to succeed in justifying its claims, provision must be made for a much larger number of measurements, and these must not be confined to the cephalic index.

Safflower-seed Oil.—Bulletin 124 of the Agricultural Research Institute, Pusa, contains an account of safflower oil. Safflower (*Carthamus tinctorius*, L.) is widely cultivated in India, both as an oilseed and, to a much smaller extent, for the reddish dye (carthamin) in the flowers. The crop is extensively grown in the driest areas of the Deccan for its oilseed. The oil is edible when clarified, and is used as an adulterant for butter. The sweet-oil of Bombay is made by mixing safflower, earth-nut, and *til* seeds and expressing the oil. After boiling, safflower oil forms a gelatinous mass, and it is a drying oil. This form is used as "roghan," or Afridi wax, for the preparation of wax-cloth. The oil is also suitable for the manufacture of soap. It is suggested that safflower-seed oil could become a valuable commercial product on the home markets.

Date Cultivation in the 'Iraq.—Under the auspices of the Agricultural Directorate, Ministry of the Interior, Mesopotamia (Memoir 3, 1921), Mr. V. H. W. Dowson has published a very interesting and valuable report on date cultivation on the Shat el Arab, the river which conveys to the Persian Gulf the joined waters of the Euphrates and the Tigris. The Shat el Arab is the most important area of date cultivation in the world; both banks are lined with date-gardens for a distance of 108 miles, with an average width on either side of about a mile, representing about 138,000 acres. In the 'Iraq the date-palm flourishes wherever it is watered and cared for, from Ana on the Euphrates and Samara on the Tigris southwards; north of these towns the winters are too cold. Mr. Dowson describes in detail the methods of cultivation and marketing, and also enumerates the chief uses of the palm and its products—in the last instance he refers to an old Tamil song which enumerates eight hundred and one uses of the Palmyra palm, and remarks that the number of uses of the date-palm and its products is probably but little short of this number. Compared with many fruit-trees, the date-palm suffers but little from disease; its one important enemy is the larva of a Gelechiid moth, the adult of which is unknown. Preventive measures against the ravages of this pest, which causes the young green dates to turn brown and drop to the ground, have still to be devised. In a second part of the memoir the author gives a statistical summary of his investigation into the yield of the different varieties, and in a third part (in preparation) he will deal generally with the varieties of date-palms of the 'Iraq, which includes also the Bagdad area, the next largest date-cultivation centre in the country, comprising about twenty miles of date-gardens lining both banks of the Tigris. The memoir is illustrated with numerous photographic reproductions.

British Mycological Society.—In pt. 3 of vol. 7 of the Transactions of this society Mr. Petch, of Ceylon, continues his studies in entomogenous fungi, writing learnedly of the Nectriæ parasitic on scale insects. A number of new species are described, but it is very unfortunate that no cultural data are given. An interesting account of the recently founded Imperial Bureau of Mycology, with a suggestive *résumé* of its functions, is contributed by the director, Dr. E. J. Butler. The establishment of this bureau is somewhat of an epoch-making event in phytopathology, and all support possible should be rendered to it. Messrs. Brooks and Searle give an account of the fungi responsible for certain tomato diseases, emphasising what should be so obvious: the necessity of cultural data in specific determinations. There are also an interesting paper by Miss Mounce on homothallism and the production of fruit-bodies by

monosporous mycelia in the genus Coprinus, and a note by Mr. Collet describing viability in *Fumago vagans* after sixty-seven years' preservation as a herbarium specimen. The issue is well produced and illustrated by five plates, two of which are beautifully coloured.

SILICIFIED PLANT REMAINS.—The Middle or Lower Devonian flora discovered by Dr. Mackie at Rhynie, in Aberdeenshire, was generally reviewed by Prof. F. O. Bower in 1920 (NATURE, vol. 105, pp. 681 and 712). Dr. Kidston and Dr. W. H. Lang (Trans. Roy. Soc. Edin., vol. 52, pt. 4, 1921) now describe the thallophytes occurring in the remarkable silicified peat-bed, and discuss the conditions of accumulation. The sequence is due to continued growth on a land-surface that was at times submerged in lake-waters impregnated with silica. A volcanic source is suggested for the silica, and it is pointed out that the growth of cyanophaceæ and bacteria in modern hot springs is known to promote a deposition of colloidal silica. We may note that Prof. W. N. Benson (Proc. Linn. Soc., New South Wales, vol. 45, p. 315, 1920) refers the silicification of remains of gymnosperms in Carboniferous beds on Mount Cobla, New South Wales, to contemporaneous hydrothermal solutions associated with the deposition of keratophyric tuffs. In view of climatic changes in the past, the possibility of the spread of siliceous waters derived from laterisation must not, of course, be overlooked.

AUSTRALIAN METEOROLOGY.—Meteorological statistics for the Australian Colony of Victoria have recently been published, based on all the available records obtained at 1046 official stations from January, 1856, to December, 1907. They have been prepared under the direction of Mr. Pietro Baracchi, Government Astronomer from 1895 to 1915. Observations were commenced at Melbourne in 1840 and continued until 1851, when, in consequence of Government changes, there seems to have been a break for about four years. From 1855 observations were made at Melbourne and at some twenty stations in different districts of the Colony. All observations were controlled by the authorities at Melbourne Observatory until 1907, when the meteorological duties were taken over by the Government of the Commonwealth of Australia under the control of the Commonwealth Meteorologist, Mr. H. A. Hunt. The observations included in the volume received are a summary of results to 1907, when the responsibility of Melbourne Observatory ceased. This volume of the early Australian weather observations is of great value as affording data for seasonal changes and possibly showing meteorological irregularities of interest in connection with more recent observations. A detailed history is given of the development of the system of observing and showing the requirements and value of meteorological observations, especially a thorough knowledge of rainfall distribution. Many details given in the introduction are of extreme value, and show most thorough supervision and great alertness as to the utility of special observations. At Melbourne observations are given for a period of fifty years. The mean and extreme values for the several elements and for the different regions of observation are of high scientific value.

STANDARD CELLS OF LOW VOLTAGE.—In the issue for November, 1921, of the Proceedings of the Physico-Mathematical Society of Japan Mr. J. Obata describes the investigation he has carried out on the possibility of constructing standard cells of low voltage for testing purposes. Nine types of cell have been studied, in all of which cadmium or cadmium amalgam formed the negative, and cadmium or lead amalgam the positive pole. The electrolytes were solutions of lead or cadmium sulphate, chloride, bromide, or iodide, and the cells were given the H form. The two cells which proved most suitable for standards were the cadmium amalgam/cadmium iodide/lead iodide/lead amalgam cell with an electromotive force at 20° C. of 0·09838 volt and a temperature coefficient of 0·00024 volt per degree, and a cadmium amalgam (10 per cent.)/cadmium sulphate solution/cadmium amalgam (dilute) cell with an electromotive force of about 0·01 volt and a temperature coefficient of about 0·0004, according to the strength of the dilute amalgam.

MAGNESIUM IN ORGANIC CHEMISTRY.—Mr. H. Hepworth describes in the issue of the Journal of the Society of Chemical Industry for January 16 the recent applications of magnesium in organic chemistry. The "Grignard reaction," since its discovery in 1900, has found numerous applications in organic synthesis, and this paper is an interesting *résumé* of much recent work. The following examples will serve to illustrate the new lines of research made possible by the use of magnesium compounds. *Cyclo*pentamethylstannines, in which the ring contains an atom of tin replacing carbon, have been obtained. Tin diaryl-compounds exhibit an intense colour. Lead tetra-alkyls, lead triaryls, apparently analogous to triphenylmethyl, and mixed tin and lead compounds have been prepared, and *l*-phenylchloroacetic acid is converted by magnesium phenyl bromide into *d*-diphenylsuccinic acid. The use of ether in preparing the Grignard reagent is not essential, but the early view that an additive compound was formed seems to have received confirmation by the isolation of a crystalline compound, $2(C_7H_7)_3PO,CH_3MgI$, when tribenzyl phosphine oxide is used instead of ether, and of crystalline $(C_5H_{11})_2O,MgCH_3I$ with amyl ether. Instead of the oxonium structure for such compounds, a formula in which magnesium is the central atom with co-ordination number 4 has been proposed, the ether being attacked by subsidiary valencies.

VIBRATIONS OF VEHICLES.—According to an article by M. A. Boyer-Guillon in the November issue of the Bulletin of the Société d'encouragement pour l'Industrie nationale, the Auclair and Boyer-Guillon accelerometer is to be used in the near future in a detailed study of the oscillations, shocks, or vibrations to which the rolling stock of the French railways is subjected. The Automobile Club of France and the Society of Architects propose also to use it in a study of the vibrations of buildings. The instrument has already led to the solution of problems connected with the failure of machines apparently well designed for the stresses they were expected to withstand. In most cases it has shown that the accelerations to which parts of the machines were subjected were far in excess of those contemplated. Used on autocars in Paris streets it gives the vertical accelerations on irregular wood and on good stone pavements as between 6 and 7 metres per sec. per sec. at a speed of 27 km. per hour. The instrument itself consists of a heavy mass held up by springs attached to the ends of rods which project radially from it. The springs are of graduated strengths, and each holds the rod to which it is attached against a stop with which it makes electrical contact until the down acceleration breaks the contact, and the break is registered on the revolving drum of a chronograph.

The Standardisation of Radium Ampoules for Therapeutic Use.

AN apparatus for the routine standardisation of ampoules containing radium compounds and emanation by the γ-ray ionisation method was installed recently at the Institut Curie. It consists, as

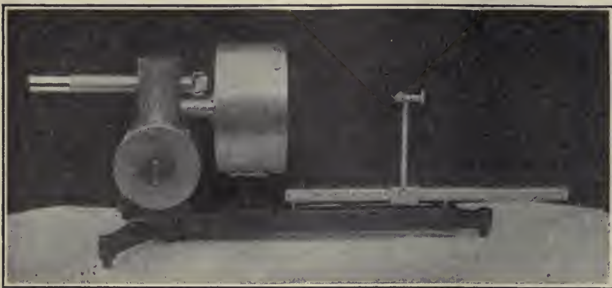


FIG. 1.—Apparatus for the standardisation of radium ampoules (one-tenth full size).

shown in Figs. 1 and 2, of a screened ionisation chamber A connected directly to a gold-leaf electroscope B. The ampoule to be tested is placed in an aluminium tray on the support C, which can be slid along a graduated rule D. The intensity of the ionisation current is deduced from the rate of fall of the gold-leaf.

A novel feature of the apparatus is the method of charging the electroscope by means of a variable multicellular condenser E, which obviates the need for a high-voltage battery.

The fixed plates of the condenser are connected to the frame, whilst the movable plates are mounted on a spindle actuated by an ebonite knob. When the condenser is in the position of maximum capacity a projecting finger F brings the movable plates momentarily into contact with the stem H, to which is connected a low-voltage battery (10–20 volts). On turning the movable plates through 180° the same finger comes into contact with another stem J connected to the electroscope; at this instant the capacity of the condenser is at its minimum and the potential proportionately increased (about thirty times).

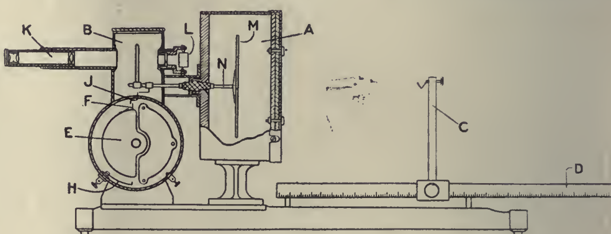


FIG. 2.—Sectional view.

The gold-leaf is observed by means of a microscope K the eyepiece of which is fitted with an angular scale; a small mirror L serves to illuminate the field of the microscope. The ionisation chamber consists of a cylindrical brass box containing a thin aluminium disc M, which is connected to the electroscope through the amber-insulated rod N. The end of the box facing the ampoule is closed by a screen consisting of two lead plates each 5 mm. thick.

A modification of the apparatus is used for measuring the radio-activity of ores, earths, etc. The electroscope, the charging condenser, and the substance to be tested occupy separate compartments of a cylindrical brass box. The radio-active substance is placed on a tray immediately underneath a rounded stem, the upper end of which forms the pillar of the electroscope. The latter is charged by means of a variable condenser identical with the one previously described, but it can, if desired, be charged independently or connected to a separate ionisation chamber. The electroscope is "earthed" by turning a milled head.

Both instruments were designed by M. Holweck, of the Institut Curie, in collaboration with the manufacturer, M. Beaudouin, Paris.

Life-cycles of Bacteria.

IN a preliminary communication published in 1916 Dr. Löhnis expressed the view that all bacteria pass through a definite life-cycle, and the present publication[1] is an extensive review of the literature in support of that contention. The volume also includes a chapter on methods, an extensive bibliography, and more than 350 microphotographs of the forms observed.

Briefly, the life-cycle is as follows:—Under certain conditions the cells come together and fuse, forming an amorphous mass—the symplastic stage—in which the protoplasm undergoes a thorough mixing. The symplastic stage is formed not only in cultures in artificial media, but, in the case of the pathogenic organisms, in the body of the host as well. It forms the connecting link between the various subcycles of which the life-cycle of the organism may be composed. All kinds of vegetative cells, as well as all the varieties of reproductive organs described by the author, can give rise to the symplastic stage. From the symplasm the so-called regenerative units always arise, and these either grow into new cells or several of them unite to form new cells directly.

Six distinct types of reproductive organs have been described by the author. These are:—(1) Gonidia, two to four or more in each cell. They are generally motile and slightly more resistant than vegetative cells. Many are filter passers. They grow into vegetative cells. (2) Regenerative bodies, distinct from regenerative units. They are spherical, oval,

[1] Part 1, Review of the Literature (1838–1918). By Dr. F. Löhnis. National Academy of Sciences, Washington, vol. 16, second Memoir. Pp. 252+41 plates.

pear- or kidney-shaped or more or less irregular, rod-shaped, and branched. They are readily stainable, generally motile, and fairly resistant. They may multiply by fission or budding, are formed from vegetative cells or from the symplasm, and may give rise to vegetative cells or to the symplastic stage. (3) Exospores, unstainable regenerative bodies. (4) Endospores, produced by vegetative cells or by regenerative bodies. Conditions for formation are similar to those for the formation of regenerative bodies. (5) Arthrospores, easily stainable, but withstand drying better than heating. They are formed by the segmentation of vegetative cells and transformation of the joints into fairly resistant spherical bodies. (6) Microcysts, very similar to arthrospores. They are formed by vegetative cells growing and becoming spherical with a thickened membrane. After a rest period they may become vegetative cells, germinate like spores, or may break up into two, three, or four segments, which become vegetative cells. In addition to their reproductive function exospores, endospores, arthrospores, and microcysts are, in the first place, resting-stages.

Besides the formation of the symplasm a second mode of interaction between the protoplasmic bodies in bacterial cells has been observed. This consists in the union of two or more cells, and is termed "conjunction" by the author. Conjunction is most common in cultures two to four days old, and generally precedes the formation of gonidia, reproductive bodies, exospores, and endospores.

The publication brings together an overwhelming amount of evidence as to the existence of the various forms distinguished by the author. The arrangement of these forms in the life-cycles of the bacteria is a point on which further information is desirable, but this will, doubtless, be provided in the later publication in which the observations of the author are to be dealt with in detail. From the point of view of the student of bacterial morphology the publication must be regarded as one of first-rate importance. The general worker on bacteriological problems will also find in it much information of a highly valuable nature, and doubtless will be able to confirm the existence of many of the forms observed from the results of his own experience.

Miners' Lamps.[1]

OF late years there has been a tendency on the part of makers of miners' safety lamps to employ thin sheet-metal, perforated with holes of small diameter, to serve the same purpose as wire gauze—that is to say, with holes large enough to admit of the passage of the necessary volume of air through them, but small enough to arrest the passage of flame. It will be recalled that the lamp invented by George Stephenson depended upon perforated sheet-copper for its impermeability to flame. A further innovation that has recently been gaining ground is the addition of a short glass cylinder, known as the "combustion tube," to the lower end of a metal chimney suspended directly above the flame of the lamp. This contrivance promotes a better circulation of air in the lamp, keeps the products of combustion separate from the incoming air, and, as a consequence, produces a brighter flame and enhances the lighting power of the lamp.

Metal chimneys have long been employed with this object, notably in the Mueseler lamp—the only kind of safety lamp permitted in Belgian mines—but as the bottom of the metal chimney cannot be brought lower down than the top of the flame without obstructing the light, the benefit derived from their use is limited. In this respect the glass extension is distinctly beneficial.

[1] Mines Department. Miners' Lamps Committee. Memorandum No. 4: Record of research on the passage of flame through perforated plates and through perforated tubes of small diameter. Pp. 12+6 plates. (H.M.S.O.) 9*d*. net. Memorandum No. 5: Record of research on the passage of the flame of an explosion from within miners' lamps fitted with chimneys. Pp. 12. (H.M.S.O.) 6*d*. net.

Having regard to the changes of this kind which were taking place in the construction of safety lamps, the Home Secretary appointed the Miners' Lamps Committee in 1919 to inquire into, and report on, various questions relating to safety lamps, and the Secretary for Mines re-appointed the same Committee in January, 1921. Up to the present the Committee has issued five Memoranda, of which the last two, Nos. 4 and 5, issued in the end of last year, deal with the use of perforated metal plates and chimneys respectively.

The experiments described in Memorandum No. 4 were made to ascertain the relative resistance to the passage of flame possessed by metal plates of various thicknesses perforated with holes of various diameters; and those described in Memorandum No. 5 to ascertain the relative resistance of chimneys of various lengths and diameters at top and bottom and extending to higher or lower levels above and below the wire gauze diaphragm by which they are supported.

The results are tabulated in both memoranda and in the letter to the Secretary for Mines which accompanies each the chairman of the Committee makes certain recommendations and suggestions founded on these results. The total cost of the Committee's inquiry to date (November, 1921) is given as 550*l*.

Pébrine in Silkworms.

IN an interesting report on pébrine in silkworms in India (Memoirs Dept. Agric. in India, Bacteriological Series, vol. 1, No. 8, November, 1920, pp. 75, 26 plates), Mr. C. M. Hutchinson gives an account of experimental work on methods of infection. He found infected ova in the pupal ovary, and the infection is traced in the egg, larva, and pupa—and recounts the life-history of the causal organism, *Nosema bombycis*. The Pasteur method of searching for the organism, devised more than fifty years ago, consists in crushing the body of the moth in a mortar, and examining, under a magnification of about 600, a small fraction of the resulting powder in a drop of water, to ascertain if the characteristic spores of Nosema are present. This method, according to the author, has not been attended in India with any approach to the measure of success which has been attained in Europe. The chances of non-detection of infected moths, and the risk of spreading the spores (due to careless application of the method) in the rooms used for examining the moths, are considerable—the author states that he has seldom failed to find Nosema spores in the floor dust from these rooms, even in cases where the floors were of concrete. In Europe a period of several months elapses between oviposition by the moth and hatching of the eggs, so

that the examination of the moths can be undertaken when they have undergone natural desiccation, and the Nosema, if present, is likely to be in the form of the readily recognisable spores. In India the eggs hatch out within eight days after they are laid, and during this period all the moths must be examined. Rapid desiccation prevents the Nosema forming spores, and the number of spores present in a rapidly dried moth may be so small as to escape detection by the Pasteur method. The author's revised method, depending on the fact that infection is chiefly in the chyle stomach, is to remove with needles a portion of this organ to a slide, rub it up in water, and examine it microscopically. Incidentally he remarks on the inefficiency of the copper sulphate solutions usually employed for sterilising rearing houses and appliances in Bengal, but he found that formaldehyde, employed as vapour or in 1 per cent. solution, completely destroyed the infective power of Nosema spores. A hopeful line of inquiry seems to be opened up by experiments which indicate that resistance to infection is increased by hill rearing.

University and Educational Intelligence.

BIRMINGHAM.—A post-graduate course of lectures on "Medical Aspects of Crime and Punishment" has been arranged.

The council of the University has appointed Mr. Alfred Piney to be lecturer on pathological histology.

Acting on the recommendation of the Senate, the council has approved of the following grants in aid of research for the current year:—Physics, 100*l.*; chemistry, 250*l.*; and zoology, 200*l.*

The Vice-Chancellor, Treasurer, Principal, and Vice-Principal have been appointed representatives of the University for the Conference of Universities to be held in London on May 13 next.

CAMBRIDGE.—On the recommendation of the General Board of Studies it has been decided that Mr. C. G. Lamb shall be appointed reader in electrical engineering, and that, subject to confirmation by the Special Board for Mathematics, Sir Gerald Lenox-Conyngham shall be appointed reader in geodesy.

It is proposed to confer the honorary degree of Sc.D. upon Baron A. A. A. von Hügel, Trinity College, late curator of the Museum of Archæology and Ethnology.

A visiting fellowship of the annual value of 2000 dollars, tenable for not more than three years, has been founded at Princeton University by Mr. William Cooper Procter for residential study and investigation in the Graduate College of Princeton University. An unmarried male graduate who is a citizen of this country, and not more than thirty years of age, is eligible for appointment, and the visiting fellow must give himself wholly to study and investigation in one of the purely liberal arts and sciences while holding the fellowship. Applications must be made to the Vice-Chancellor not later than the end of March.

It is notified that the Royal Commission for 1851 has decided to establish certain senior studentships of the value of 400*l.* a year, for which nominations may be made by the University of Cambridge, amongst others. Applications will be made through the professor or head of a laboratory or department under whom the candidate has already carried out research.

The Royal Agricultural Society has offered for the Agricultural School at Cambridge the income of the Hills Bequest for the investigation of the value and uses of the rarer forms of ash in the cultivation of crops.

LEEDS.—The council of the University has appointed Mr. A. Wormall demonstrator in biochemistry.

LONDON.—The following doctorates have been conferred:—*Ph.D.* (*Science*): Mr. H. T. Flint, for a thesis entitled "Integration Theorems of Four-dimensional Vector Analysis"; Mr. R. J. Ludford, of University College, for a thesis entitled "Studies in Gametogenesis: Pt. 1, Contributions to the Study of the Oogenesis of Patella, containing the Mitochondria and Gogli Apparatus in relation to Vitellogenesis in Patella; Pts. 2 and 3, Dictyokinesis in Germ-cells, and the Gogli Apparatus during Cell-division"; Mr. H. Moore, for a thesis entitled "The Season-cracking of Brass and other Copper Alloys"; and Mr. S. H. Tucker, for a thesis entitled "Carbazole."

ST. ANDREWS (UNITED COLLEGE).—The Gray prize in logic for an essay on Kant's "Deduction of the Categories" to Mr. Norman McLeish, and the Tyndall Bruce logic prize for an essay on "The Conception of Substance" in Descartes, Locke, Berkeley, and Hume to Mr. Norman McLeish.

THREE fellowships, each of the yearly value of 200*l.*, tenable for two years, are offered by the University of Wales to graduates of that University. Information respecting the fellowships can be obtained from the Registrar, University Registry, Cathays Park, Cardiff. The latest date for the receipt of applications for the fellowships is May 31 next.

MR. L. P. W. RENOUF, assistant lecturer in zoology in the Technical College, Bradford, has recently been elected to the professorship of zoology in University College, Cork. Prior to his appointment at the Technical College, Mr. Renouf was lecturer and examiner in zoology in the University of Glasgow and director of the Bute Laboratory and Museum.

THE annual general meeting of the Association of Technical Institutions will be held at the Leathersellers' Hall, St. Helen's Place, London, E.C., on Friday and Saturday, March 3 and 4. On the Friday morning the president, Viscount Burnham, will introduce the president-elect, the Right Hon. Walter Runciman, who will deliver an address. Papers to be presented are:—"Diplomas," Dr. Clay; "Certificates for Evening Students," Principal Hogg; and "A Mechanical Engineering Diploma," Brig.-Gen. Mowat. Sir Alfred Keogh, Rector of the Imperial College of Science and Technology and a past-president of the association, will attend the meeting on Friday afternoon and speak on the subject of diplomas for higher technical education and work of a university standard.

THE report for 1921 of the Association of Science Teachers contains the findings of a sub-committee appointed to consider the new regulations relating to the examination for the clerical class of the Civil Service. Referring to the science syllabus, the committee is of opinion that, in view of the fact that pupils of secondary schools are expected to take the First School Examination at the age of 16½ years, it is to be regretted that the science syllabus in the Civil Service regulations is not more in accordance with that adopted for the First School Examination; further, that teaching along the lines laid down in the new Civil Service syllabus would tend to the acquisition of a superficial knowledge of useful facts in modern science without necessarily affording a training in scientific method. The report also includes an account of the general meeting of the association held in London on January 3 last, and referred to in NATURE of January 12, p. 57.

Calendar of Industrial Pioneers.

February 23, 1860. Joseph Miller died.—Trained as a mechanical engineer at Boulton and Watt's, Miller in 1822 with Barnes established one of the most successful marine engineering works on the Thames. He was a promoter of screw propulsion, and for H.M.S. *Amphion* built the first set of direct-acting screw engines placed below the water-line.

February 24, 1815. Robert Fulton died.—Famous as the pioneer of steam navigation in the New World, Fulton was born in 1765, and in early life attained success as an artist. Afterwards in England and France he turned to mechanical pursuits; in 1800 he constructed a submarine, and in 1803 experimented with a steamboat on the Seine. He returned to America in 1806, and the following year built the *Clermont*, which, driven by an engine constructed by Boulton and Watt, ran successfully between New York and Albany. Among other vessels built by him was the *Demologos*, the first steam man-o'-war.

February 24, 1875. Marc Seguin died.—A nephew of the aeronaut Montgolfier, Seguin was the first to construct an iron-wire suspension bridge and one of the earliest of French railway engineers. In 1827 he invented the tubular boiler, and the same year applied it to a locomotive for the railway from St. Etienne to Lyons. He also made scientific investigations and endeavoured to develop the mechanical theory of heat.

February 26, 1834. Alois Senefelder died.—The inventor about 1798 of the art of lithography, Senefelder, who in his youth was connected with the stage, was led to his discovery through seeking for a cheap method of reproducing his comedies. He established a lithographic establishment at Munich, and afterwards was Director of the Bavarian Royal Lithographic Office.

February 27, 1794. Jean Rudolphe Perronet died.—Perronet has been called the Telford of France. From the office of the City Architect of Paris he entered the Government service, and in 1747 became the first director of the Ecole des Ponts et Chaussées founded by Trudaine. He was the first to introduce bridges with level roadways, and among his most notable works was the bridge across the Seine at Neuilly.

February 27, 1913. Sir William Henry White died.—From an apprentice at Devonport Dockyard White rose to be Chief Constructor of the Navy, a post he held from 1885 to 1902. During this period he was responsible for the construction of 245 vessels costing about 100,000,000*l*. A great master of his profession, he added much to the literature of naval architecture, held the presidencies of various technical societies, and was instrumental in forming the Royal Corps of Naval Constructors.

February 28, 1875. Sir Goldsworthy Gurney died.—One of the pioneers of the steam road carriage, Gurney practised as a surgeon at Wadebridge and then in London. He was the inventor of the Drummond light, the steam blast, and a water-tube boiler, and in 1829 went from London to Bath in a steam-driven carriage at 15 miles an hour.

March 1, 1911. Robert McAlpine died.—McAlpine is regarded as the father of wood-pulp paper. Emigrating from Scotland to Massachusetts at the age of sixteen, he mastered the business of paper-making, and in 1867 produced the first sheet of paper made from ground wood-pulp, the initial step in the production of abundant supplies of cheap paper.

E. C. S.

Societies and Academies.

London.

Royal Society, February 16.—Sir Charles Sherrington, president, in the chair.—L. **Hill**, D. H. **Ash**, and J. A. **Campbell**: The heating and cooling of the body by local application of heat and cold. When the hands are heated or cooled by water the amount of heating or cooling is large, but not constant for a given range of temperature. The degree of heating or cooling is obtained from the temperature of the skin over the median vein at the elbow, the thermometer used being coiled and insulated from the air. Loss of 20 to 25 kilo-calories of heat from the hands in thirty minutes, *i.e.* a loss almost equal to the basal metabolism, does not appreciably affect the body metabolism.—J. B. **Cohen**, C. H. **Browning**, R. **Gaunt**, and R. **Gulbransen**: Relationships between antiseptic action and chemical constitution, with special reference to compounds of the pyridine, quinoline, acridine, and phenazine series. Certain acridine derivatives, salts of diamino-acridine and the methochloride of this base, are extremely potent antiseptics. Pyridine and quinoline derivatives ("fragments" of the acridine molecule), a number of acridine derivatives, and some phenazine compounds were also investigated, but none approximate to diamino-acridine in antiseptic properties. Dealing with the acridine group, the presence of amino-groups increases antiseptic power, and effectiveness in serum is a characteristic of compounds with unsubstituted amino-groups, and especially of their methochlorides. Other radicals replacing the methyl group in the methochloride do not alter the antiseptic action, but substitution of alkyls in the amino-group tends to diminish antiseptic action, while acetylation or replacement of the amino-group destroys it. Antiseptic action on organisms of different types shows marked irregular variation.—D. T. **Harris**: Active hyperæmia. The lingual nerve contains true vaso-dilator and the sympathetic vaso-constrictor fibres; both are equally independent of the intervention of metabolites. Experiments show that increased blood-supply during muscular activity is due entirely to the products of metabolism, and of the metabolites estimated carbon dioxide and α-hydroxy organic acids were increased. Vaso-dilator nerves are concerned with the control of body temperature; active hyperæmia in the dog's tongue may be induced by reflex excitation of the vaso-dilator nerves through the stimulation of heat receptors in the skin.—B. B. **Sarkar**: The depressor nerve of the rabbit. The depressor nerve of the rabbit is connected in part with a special collection of ganglion-cells in the vagus, distinct from the ganglion of the trunk, which may extend into the superior laryngeal or the vagus trunk. These cells probably give rise to the afferent fibres of the depressor. The nerve is usually formed by two branches, one from the superior laryngeal and one from the vagus, and is connected with the inferior cervical ganglion, the root of the aorta, and the base of the heart. The left nerve of the pair is generally larger and contains more fibres than the right. The depressor contains medium-sized and very fine myelinated fibres, and others which are non-myelinated. Probably it is not wholly formed of afferent fibres, for these fine myelinated and non-myelinated fibres presumably belong to the autonomic nervous system and are efferent.—A. **Lipschütz**, B. **Ottow**, C. **Wagner**, and F. **Bormann**: The hypertrophy of the interstitial cells in the testicle of the guinea-pig under different experimental conditions. Partial castration often causes enormous hypertrophy of the interstitial tissue. This hypertrophy is not compensatory, for the tendency to

hypertrophy of interstitial cells is more marked in fragments with improved blood-supply. Hypertrophy appears to be independent of the internal secretory function of the testicle in its relation to the organism as a whole, and is a response to local conditions.

Linnean Society, February 2.—Dr. A. Smith Woodward, president, in the chair.—F. **Johansen**: The Canadian Arctic Expedition of 1913–18. The expedition started from Vancouver in the *Karluk* for Nome, in Alaska, where the equipment was procured. One party, under Mr. Stefansson, on the *Karluk* was caught in the ice in September, 1913, and carried westward until the vessel sank, in about 73° N. lat. and 160°–165° W. long. The party camped on an ice-floe, and the survivors reached Siberia in March, 1914, and Nome in May. Stefansson later organised a new search-party to proceed by sledge across Banks Land; he explored Parry Islands, discovering coal in Melville Island. Coasts hitherto unmapped were surveyed, and much geological and biological material was gathered, as well as many implements used by Esquimaux.—J. C. **Willis** and G. U. **Yule**: Some statistics of evolution and geographical distribution in plants and animals and their significance. The general result seems to show that evolution and geographical distribution have proceeded in a chiefly mechanical way, the effects of the various "other" factors that intervene—climatic, ecological, geological, etc.—being only to bring about deviations this way and that from the dominant plan. Every family and every genus, and in every country, behaves in the same way. Strong evidence is thus given for de Vries's theory of mutation and for Guppy's theory of differentiation (see NATURE, February 9, p. 177).—Mrs. E. M. **Reid**: Note on the hollow curve as shown by Pliocene floras. The material was that published from Tegelen, Castle Eden, etc. Fossil floras take their appropriate place alongside living floras, bringing direct evidence from the host to show the universality of the law of hollow-curve distribution.

Aristotelian Society, February 6.—Prof. Wildon Carr in the chair.—A. H. **Hannay**: Standards and principles in art. The problem of standards and objectivity in art is usually debated on the basis of standards and objectivity or no standards and subjectivity. Each new and individual work of art carries with it its own individual and original awareness. This view does not necessitate a lapse into subjectivism if it is realised that the awareness or taste is itself a striving for objectivity and rightness. The search for standards is the outcome of this incessant quest for right taste. Beauty is not entirely unique and indefinable. It is a process, a constructing, and can be differentiated from other processes such as history, science, and philosophy. Actually, modern criticism is full of psychological analyses which definitely involve reflective principles, but they are distinct from the old standards, for they do not pretend to anticipate the individual content of works of art. But do they precede, accompany, or follow upon æsthetic creation and appreciation? It is accepted that they are a later product, and this view has been stated very lucidly by Benedetto Croce. Yet history does not confirm it, and it does not explain the fact that criticism clarifies taste. It is suggested that the process imagination-principle is not a passage from one independent activity to another, but a development which requires both activities and in which a modification in one means a modification in the other. The critic emphasised the universal element, while the artist emphasised the individual element.

Zoological Society, February 7.—Dr. A. Smith Woodward, vice-president, in the chair.—C. W. **Hobley**: The fauna of East Africa and its future. Special attention was directed to the need for immediate action to preserve the herds of big game from total extinction.—Miss L. E. **Cheesman**: The position and function of the siphon in the amphibious mollusc *Ampullaria vermiformis*.—J. **Stephenson**: Contribution to the morphology, classification, and zoogeography of Indian Oligochæta. IV.: The diffuse production of sexual cells in a species of Chætogaster (fam. Naididæ). V.: *Drawida japonica*, Michlsn., a contribution to the anatomy of the Moniligastridæ. VI.: The relationships of the genera of Moniligastridæ, with some considerations on the origin of terrestrial Oligochæta.

Physical Society, February 10.—Dr. A. Russell, president, in the chair.—E. A. **Owen** and Bertha **Naylor**: The measurement of the radium content of sealed metal tubes. Tables have been compiled giving the corrections to be applied to the observed radium content of sealed platinum and silver tubes to obtain their true radium content. Two cases have been considered: (*a*) that in which the active deposit is uniformly distributed throughout the volume of the tube, and (*b*) that in which the active deposit is uniformly distributed over the inner wall of the tube. With constant wall-thickness the correction increases with the external diameter of the tube, and for the same increase of external diameter the increase of correction is more pronounced for the "empty" than for the full tube.—Sir William **Bragg**: The crystal structure of ice. The methods of X-ray analysis have been applied to ice by Ancel St. John and by D. M. Dennison. The former refers the structure to a lattice composed of right triangular prisms of side 4·74 Å.U. and height 6·65 Å.U.; the latter to a similar lattice of dimensions 4·52 Å.U. and 7·32 Å.U. respectively. The arrangement of the atoms was not found. On certain suppositions the arrangement can be found independently of direct X-ray analysis. Assume that each positive ion is surrounded symmetrically by negative ions, and *vice versa*; and, in view of the low density of ice, let the number of neighbours be in each case as small as possible. The crystal is to be hexagonal and to have the right density. Then each oxygen atom is at the centre of gravity of four neighbouring oxygens, from each of which it is separated by a hydrogen atom. The dimensions of the structure agree with Dennison's figures, and the calculated intensities of reflection agree well with the observed intensities recorded by Dennison.—Kerr **Grant**: A method of exciting vibrations in plates, membranes, etc., based on the Bernoulli principle. A plate placed close to a flanged orifice from which a stream of air or liquid is issuing is attracted towards the orifice. If the plate be mounted as a diaphragm it can be excited to strong vibration by a suitable blast, and a loud sound is produced with high efficiency.

Faraday Society, February 13.—Prof. A. W. Porter, president, in the chair.—J. R. **Partington**: The energy of gaseous molecules. The translational and rotational energies of gases are, at ordinary temperatures, approximately represented by the theory of equipartition, and any excess of C_v over 6 may be put down to internal motions. This excess is parallel to the activities of the gases. The translational energy may be represented on the quantum theory with a frequency equal to the collision frequency. The value of n in the equation $n=n_0(T/_{273})^n$, representing the effect of temperature on the viscosity, is related to the critical pressure (p_c in atm.) by the empirical equation $n=0{\cdot}642+0{\cdot}00116\,p_c+0{\cdot}0000399\,p_c^2$. The molecular heat of hydrogen may be represented empirically

by Debye's formula with a frequency $\nu = 6541/\sqrt{T}$. The molecular heat of nitrogen is very approximately given by a molecule based on Bohr's theory, with a frequency given by the gyrostatic formula.—U. R. **Evans**: Passivity and overpotential. (1) Where a metal is corroded by a liquid yielding an insoluble corrosion product, the latter may either cling to the metal, forming a thin protective covering (often invisible), or it may become dispersed in the solution; in the latter case it will not seriously interfere with corrosion. It is probably the relative values of the interfacial tension between the metal, corrosion-product, and solution that determines which will occur. (2) The activation of passive metals by chlorides is related to the known peptising action of metallic hydroxides by chlorides; the passivication by means of chromates is connected in part with the flocculating action of chromates. (3) The fact that metals with basic oxides are rendered active by acids and passive by alkalis, whilst those with acidic oxides tend to become passive in acids and active in alkalis, shows that the invisible protective layer is "of the nature of an oxide-film." But it seems wrong to identify it with any oxide known in the massive state; probably we have to deal with a layer of oxygen atoms connecting the metal on one side to the solution on the other. (4) Likewise, at a cathodically polarised electrode we probably have to deal with a layer of hydrogen nuclei connecting the metal to the liquid. The hydrogen is probably in a state intermediate between the elementary and the ionic, and by forming a link between metal and solution it serves to decrease the energy of the interface. Overpotential may be due to the energy needed to desorb the hydrogen.—A. W. **Porter**: Note on the vapour-pressure of ternary mixtures. The equation proposed for ternary mixtures in a previous paper is here applied to the case of mixtures of toluene, carbon tetrachloride, and ethylene bromide, and is found to be satisfactory.

Royal Meteorological Society, February 15.—Dr. C. Chree, president, in the chair.—C. E. P. **Brooks** and J. **Glasspoole**: The drought of 1921. The general rainfall in England and Wales was the least in 1921, so far as can be ascertained, since 1788. Individual long records indicated that over a considerable part of the south-east of England 1921 was the driest year for at least a century and a half. The months of 1921 were not individually so remarkable as was shown by a comparison with the driest months known to have occurred in the British Isles generally. As shown by a map of standard deviation of annual rainfall, 1881–1915, for the British Isles, the least fluctuations of annual rainfall occurred along the coast in the north-west, increasing to a maximum in the south-east and centre of the land masses. Constructing charts showing the distribution of barometric pressure over the globe during and preceding each of the great droughts, beginning with 1864, it is found that the conditions which commonly prevail during dry spells are high pressure over the British Isles, the greatest deviation from normal being usually over south-east England; low pressure over the Arctic regions, especially near Spitsbergen; and, generally, low pressure over the tropics. The first factor is related to the eleven-year sun-spot cycle, occurring most frequently two years after sun-spot minimum and three or four years after sun-spot maximum, so that it tends to recur every five or six years. Low pressure over the Arctic is related to ice conditions, and tends to recur every four or five years. Great droughts occur only when both these factors are favourable. With pressure low over the Arctic, two or three months' warning of a drought would be given by the development of high pressure over northern Russia.—T. **Kobayasi**: A cyclone which crossed the Korean Peninsula and the variations of its polar front The cyclone passed over a mountain range in Korea on March 25, 1918. It induced a secondary on the farther side of the range along the steering line, which extended upward until it joined with the primary; the secondary gradually grew stronger, and the original centre disappeared. The existence of the polar front was very distinctly marked, but complicated in character. There were two or more squall lines for one steering line.

EDINBURGH.

Royal Society, February 6.—Prof. F. O. Bower, president, in the chair.—J. M'Lean **Thompson**: The floral structure of *Napoleona imperialis*, Beauv. The flower structure of this curious African plant of the Myrtle family has remained a puzzle since the discovery of the plant in 1786. The flowers possess inside the corolla a series of petal-like growths, which it was held were produced during descent by transformation and replacement of cycles of stamens of a myrtle type of flower. These petaloid growths and the persisting cycle of stamens, which themselves are now partly sterile, are associated with a massy fleshy disc which surrounds the base of the style. The disc, stamens, and petaloid growths in question have now been shown from developmental study to have a common origin from a ring-like outgrowth which normally in the Myrtle family bears numerous groups of stamens, and were held to be the results of replacement of stamens during descent.—G. W. **Tyrrell**: The pre-Devonian basement complex of Central Spitsbergen. The rocks described constitute the basement which underlies the flat-lying Devonian and Carboniferous sediments in the region about the head of Klaas Billen Bay. They form the southern continuation of the extensive Wijde Bay region of Urgebirge, where these ancient rocks begin to be covered unconformably by a sedimentary mantle. Lithologically, they fall into a western zone of "Archæan" facies, consisting of quartz-schists, garnetiferous mica-schists, hornblende-schists and gneisses, lit-par-lit-gneisses, and augen-gneisses, with crystalline limestones; and an eastern zone consisting of slates, quartzites, and limestones similar to those of the Hecla Hoek system, the type-locality of which (Hecla Hoek, in Treurenberg Bay) lies exactly on the northern continuation of the line of strike of these rocks. Hence this group is believed to be of Hecla Hoek (probably Ordovician) age. The western schists and gneisses, while showing great similarities to rocks involved with the Hecla Hoek of the north-western mountains, may be much older, possibly even Archæan.

MANCHESTER.

Literary and Philosophical Society, November 1, 1921.—Mr. T. A. Coward, president, in the chair.—S. J. **Hickson**: Some early autographs of John Dalton. Variations in Dalton's handwriting were examined and attention was directed to certain family records.—R. W. **James**: The distribution of the electrons in atoms. When X-rays fall on an atom each electron of the atom probably becomes a source of scattered X-radiation; the waves scattered by the electrons in the direction of the incident light will be in phase, and the total amplitude scattered in this direction will be proportional to the number of scattering electrons. If the electrons in the atom lie at distances from the nucleus comparable with the wave-length of the X-rays, the waves scattered from the different

electrons in any direction making an angle with that of the incident radiation will not be in phase. Measurement of the intensity of the radiation scattered in different directions gives the diffraction pattern for the atom. The K_α doublet of rhodium falling on a crystal shows that each electron in the atom scatters independently. On the average, three or four electrons lie in the region near the edge of the atom, and the main concentration is much closer to the nucleus.

November 15.—Mr. R. L. Taylor, vice-president, in the chair.—S. **Chapman**: Certain integrals occurring in the kinetic theory of gases. In the kinetic theory of gases, if molecules are regarded as point-centres of force, the calculation of the intensity of the force from experimental determinations of gaseous viscosity depends upon numerical factors which have not hitherto been evaluated except in one case. The factors concerned have now been calculated in other cases.—J. E. **Jones**: The dynamics of collision of diatomic molecules. By the application of Maxwell's kinetic theory, a simple relation between the velocity with which the points of contact approach each other and the velocity with which they separate has been found; a simple relation between the impulse acting on each body at collision and the velocity of approach of the points of contact has been deduced and the impulse on collision calculated. The velocities after collision are then deduced from the ordinary dynamical equations of momentum.

Paris.

Academy of Sciences, February 6.—M. Emile Bertin in the chair.—L. **Lecornu**: Some remarks on relativity.—M. **Hamy**: The determination by interference of the diameters of stars the superficial brightness of which is not uniform.—C. **Richet**, E. **Bachrach**, and H. **Cardot**: The tolerance of the lactic ferment to poisons. It has been shown that the lactic acid organism gradually grows accustomed to poisons present in the culture media. It is now proved that this is specific, in the sense that a ferment grown tolerant to the presence of one poison still remains sensitive to another. The lactic ferment may be made to tolerate the presence of two different poisons simultaneously.—F. **Widal**, P. **Abrami**, and J. **Hutinel**: Researches on the proteopexic insufficiency of the liver in dysenteric hepatitis. The test previously described by the authors (enumeration of the white blood corpuscles after drinking a glass of milk, fasting) proves whether the liver is completely arresting incompletely disintegrated proteids, and this has proved to be a most sensitive test of the proper functioning of the liver. In dysentery the liver may be extensively attacked without affecting the proteopexic function.—M. **d'Ocagne**: The comparative examination of various nomographic methods.—A. **de Gramont** and G. A. **Hemsalech**: The evolution of the spectrum of magnesium under the influence of increasing electrical actions. Applications to astrophysics. From a detailed study of the effects of temperature and of the strength of the electric field on the lines of the magnesium spectrum various conclusions of interest in astrophysics are drawn. It is dangerous to conclude that a star possesses a high temperature because the spark-lines predominate in its spectrum. It is important to study the character of each line.—C. **Guichard**: Networks which are several times Ω_{00}.—J. **Timmermans**, Mlle. H. **Van der Horst**, and H. Kamerlingh **Onnes**: The melting points of pure organic liquids as thermometric standards for temperatures below 0° C. The temperatures were determined by a platinum resistance thermometer, standardised against the helium thermometer, of nine carefully purified liquids. The range covered is between −159·6° C. (isopentane) and −22·9° C. (carbon tetrachloride), with an error of less than 0·1° C. Specimens of these standard liquids will be distributed to other institutions later on.—M. **Gevrey**: Remarks on quasi-analytical functions.—G. **Julia**: Series of rational fractions and integration.—T. **Carleman**: A theorem of M. Denjoy.—G. **Sagnac**: The projection of the light of periodic double stars and the oscillations of the spectral lines.—D. **Coster**: The L series of the X-ray spectrum. The X-ray spectra of a large number of elements (from Ta to Rb) have been remeasured. In general, the new results confirm earlier work, and also give support to the theory of structure of the Bohr atom. Details are given in cases where the new measurements are not in agreement with the earlier observers.—M. **Bedeau**: Measurement of the dielectric constant of gases and vapours by means of circuits with sustained waves.—C. E. **Guye** and R. **Rüdy**: A new mode of determination of the molecular diameters by the electromagnetic rotation of the discharge in the gases. Earlier work had shown that whilst the molecular diameters obtained by this formula were of the same order of magnitude as those obtained by the viscosity method, the results were greatly influenced by the presence of traces of impurities. In the present work great care was taken in the purification of the gases, and comparative figures for the molecular diameters obtained by the electromagnetic rotation and the viscosity methods are tabulated for oxygen, nitrogen, carbon dioxide, hydrogen, nitrous oxide, methane, and carbon monoxide. The two sets are in fair agreement.—L. **Guillet** and J. **Cournot**: The variations of the mechanical properties of metals and alloys at low temperatures. Results are given for the resilience and Brinell test at 20° C., −20° C., −80° C., and −190° C. of electrolytic iron, steels, and alloys.—P. **Jolibois** and R. **Bossuet**: The relations between the different oxides of uranium. At 500° C. in a vacuum the oxide UO_3 loses oxygen, giving rise to U_3O_8, and the reaction is irreversible. The same oxide is formed by heating UO_2 in oxygen.—P. **Lebeau**: The oxides of uranium. The only oxides of uranium which have a certain existence are UO_3, U_3O_8, and UO_2. The green oxides prepared at temperatures below 800° C. contain variable quantities of uranic anhydride, and change in composition in contact with moist air.—H. **Pélabon**: The action of selenium on gold. Gold is slightly attacked by selenium; the metal fixes a little selenium, and the selenium itself takes up a little gold.—E. **Grandmougin**: Some new derivatives of sulphobenzide.—G. **Dupont**: The composition of Aleppo essence of turpentine. This turpentine contains 95 per cent. of pinene, 1·14 per cent. of inactive bornyl acetate, and 3·8 per cent. of sesquiterpene.—G. **Mouret**: The eastern limit of the granitic massif of Millevaches.—P. **Glangeaud**: The Saint-Flour Oligocene basin. The Miocene Truyère flowing into the Allier.—P. **Négris**: Glacial phases in Greece.—R. **Bourret**: The strata in the north-east of Tonkin.—L. **Dussault**: The geology of western Tonkin.—E. **Saillard**: Composition of the wild beetroots.—R. **Stumper**: New observations on the poison of ants. The concentration of the formic acid in *Formica rufa* was found to vary between 21 and 73 per cent. of pure acid. Formic acid is always present in the Camponotinæ, but absent in Myrmicinæ and Dolichoderinæ.—M. **Doyon**: The incoagulability of the circulating blood provoked in the frog by injections of nucleic acids. Duration of the phase. Comparison with various anti-coagulants.—A. A. **Mendes-Corrêa**: The asymmetry of the skeleton of the upper

limbs.—MM. **Alezais** and **Peyron**: The histogenesis and origin of the chordomes.—E. **Burnet**: A new method of diagnosis of Mediterranean fever. The test proposed is the intradermal reaction produced by a drop of a broth-culture of *Micrococcus melitensis*.—M. **Léger** and A. **Baury**: The shrew, *Crocidura Stampflii*, and the plague in Senegal. This animal has been proved to carry plague, and also fleas. Its destruction should be carried out systematically along with the rat.

Official Publications Received.

Agricultural Research Institute, Pusa. Bulletin No. 123, 1921: The Bundelkhand Cottons: Experiment in their Improvement by Pure Line Selection. By B. C. Burt and Nizamuddin Hyder. Pp. iv +15. (Calcutta: Government Printing Office, 1921.) 4 annas.

Memoirs of the Department of Agriculture in India. Entomological Series, Vol. 7, No. 6: Life-Histories of Indian Insects. Diptera: *Sphyracephala Hearseiana*, Westw. By S. K. Sen. Pp. ii +33-38+plates 4 and 5. (Pusa: Agricultural Research Institute.) 12 annas; 1*s*.

Annals of the Transvaal Museum. Vol. 8. Part 3: New South African Heterocera. By L. B. Prout and A. E. Prout. Pp. 149-186. (Cambridge: At the University Press.)

Canada. Department of Mines: Mines Branch. Annual Report on the Mineral Production of Canada during the Calendar Year 1920. Pp. 80. (Ottawa.)

Report of the Department of the Naval Service for the Fiscal Year ended March 31, 1921. (Sessional Paper No. 39: A. 1922.) Pp. 38. (Ottawa.)

The Journal of the Institute of Metals. Edited by G. Shaw Scott. Vol. 26. Pp. x+760+34 plates. (London: Institute of Metals.) 31*s*. 6*d*. net.

Abridged Edition of Tide Tables for Vancouver and Sand Heads, B.C., and Slack Water for First Narrows and Active Pass, with Tidal Differences for the Strait of Georgia. Pp. 45. (Ottawa: Tidal and Current Survey, Naval Service Department.)

Memoirs of the Department of Agriculture in India. Chemical Series. Vol. 6, No. 2: The Effect of Environmental Factors on the Alkaloidal Content and Yield of Latex from the Opium Poppy (*Papaver Somniferum*), and the Bearing of the Work on the Functions of Alkaloids in Plant Life. By Dr. H. E. Annett. Pp. ii+59-154. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 2 rupees; 2*s*. 9*d*.

Proceedings of the Rochester Academy of Science. Vol. 6, No. 2: Minerals in the Niagara Limestone of Western New York. By A. W. Giles. Pp. 57-72. Vol. 6. No. 3: The Fungi of our Common Nuts and Pits. By C. E. Fairman. Pp. 73-115+plates 15-20. (Rochester, N.Y.)

Uganda Protectorate: Annual Report of the Department of Agriculture for the Nine Months ended 31st December, 1920. Pp. 67. (Kampala: Department of Agriculture.)

Calendario della Basilica Pontificia del Santissimo Rosario in Valle di Pompei per l'Anno 1922. Pp. 240. (Valle di Pompei: Scuola Tip. Pontificia.)

Diary of Societies.

THURSDAY, FEBRUARY 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. G. Perkin: Dyeing: Ancient and Modern (2).

INSTITUTION OF ELECTRICAL ENGINEERS, at 3.30 and 8.—Meeting in Commemoration of the First Meeting of the Society of Telegraph Engineers on February 28, 1872.

ROYAL SOCIETY, at 4.30.—C. D. Ellis: β-ray Spectra and their Meaning.—Prof. A. E. Conrady: A Study of the Balance.—Dr. J. S. Owens: Suspended Impurity in the Air.—R. V. Southwell: The Free Transverse Vibrations of a Uniform Circular Disc clamped at its Centre, and the Effects of Rotation.—A. E. Oxley: Magnetism and Atomic Structure. II. The Constitution of the Hydrogen-palladium System and other similar Systems.—T. Carleman and Prof. G. H Hardy: Fourier's Series and Analytic Functions.—Prof. A. McAulay: Multenions and Differential Invariants. II. and III.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 4.30.—Dr R. L. J. Llewellyn and others: Discussion on The Etiology of Gout.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute, 90 Buckingham Palace Road, S.W.1), at 6.—A. E. Hayes: Phonoscript.

INSTITUTION OF AERONAUTICAL ENGINEERS (at Royal Society of Arts), at 7.30.—Lt.-Col. Moore-Brabazon: The Early Days of Aviation (Presidential Address).

CONCRETE INSTITUTE, at 7.30.—H. K. Dyson: What is the Use of the Modular Ratio?

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Prof. P. J. Cammidge: The Source of the Amylolytic Ferment of the Urine. —Dr. G. A. Harrison: Glycosuria in Renal Disorders.

FRIDAY, FEBRUARY 24.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Dr. J. Rennie: (*a*) The Present Position of Bee Disease Research; (*b*) Demonstration of Polyhedral Disease in Tipula Species.

ROYAL SOCIETY OF ARTS (Joint Meeting of the Dominions and Colonies and Indian Sections), at 4.30.—Prof. W. A. Bone: Brown Coals and Lignites: Their Importance to the Empire.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—Dr. C. P. Lapage and Dr. W. J. S. Bythell: Tonic and Atonic Hearts in Children (with Radiographic Illustrations).

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Dr. H. Levy: The Number of Radio-active Transformations as Determined by Analysis of the Observations.—Prof. C. H. Lees: A Graphical Method of Treating Fresnel's Formulæ for Reflection in Transparent Media.—Research Department of the General Electric Co., Hammersmith: Demonstrations of a Rapid Weighing Balance, and an Electrostatic Voltmeter.—F. C. Dyche-Teague: Demonstration of the Physical Properties of Cellactite.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. Main: A Pilgrimage to Provence.

INSTITUTION OF PRODUCTION ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—G. W. Eastwood: Intensive Production of Automobile Bodies.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—Prof. E. G. Coker: Curved Beams, Rings, and Chain Links.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. Evelyn D. Brown: The Relation between Puerperal Septicæmia and other Infectious Diseases, with Reference to the Admission of Maternity Cases into Isolation Hospitals.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. Joly: The Age of the Earth.

SATURDAY, FEBRUARY 25.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. A. Gardner: Masterpieces of Greek Sculpture (2).

MONDAY, FEBRUARY 27.

INSTITUTE OF ACTUARIES, at 5.—C. H. Maltby: Results of an Investigation into the Effects of Different Valuation Bases upon Surplus.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Association Meeting), at 7.—Sir Henry Fowler: Metallurgy in Relation to Mechanical Engineering.

ROYAL SOCIETY OF ARTS, at 8.—Prof. A. F. C. Pollard: The Mechanical Design of Scientific Instruments (Cantor Lecture) (2).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Clinical Evening.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8.30.—G. G. Turner, Sir Lenthal Cheatle, W. H. Clayton-Greene, W. James, and W. G. Howarth: Discussion on The Treatment of Tuberculous Glands.

TUESDAY, FEBRUARY 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: Anthropology of the British Empire: Series 1: Racial Problems in Asia and Australasia (2).

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. E. I. Spriggs and O. A. Marxer: A Review of Sixty-one Cases seeking Relief after Short-circuiting Operations.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—T. Bell: Present-day Portraiture.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—L. Gaster and others: Discussion on Industrial Lighting: Ideal Requirements (legislative and otherwise) and Practical Solutions.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Miss R. M. Fleming: Sex and Growth Features in Racial Analysis.

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at Institution of Mechanical Engineers), at 8.30.—Demonstration of, and Discussion on, Various Recording Instruments used on Motor Cars.

WEDNESDAY, MARCH 1.

NEWCOMEN SOCIETY (at Caxton Hall, Westminster), at 5.—R. Young: Timothy Hackworth and the Locomotive.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—Informal Discussion on The Treatment of the Acute Obstruction resulting from Carcinoma of the Colon.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—E. B. Moullin and L. B. Turner: The Thermionic Triode as Rectifier.

ROYAL SOCIETY OF ARTS, at 8.—E. Moor: The Duplex-coupler Pianoforte.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—R. V. Wadsworth: The Theobromine Content of Cacao Beans and Cocoa.—A. H. Bennett and F. K. Donovan: The Determination of Aldehydes and Ketones by Means of Hydroxylamine.—R. E. Essery: The Value of Fish Scales as a Means of Identification of the Fish Used in Manufactured Products.—N. Evers and G. D. Elsdon: The Examination of B.P. Ointments.

THURSDAY, MARCH 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. M. Lefroy: The Menace of the Insect Pest: The Balance of Life in Relation to Insect Pest Control (1).

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Prof. L. N. G. Filon and H. T. Jessop: The Stress-optical Effect in Transparent Solids strained beyond the Elastic Limit.—W. E. Curtis: The Structure of the Band Spectrum of Helium.—S. Datta: The Spectrum of Beryllium Fluoride.—W. G. Palmer: The Catalytic Activity of

Copper. Part III.—Dr. G. B. Jeffery: The Motion of Ellipsoidal Particles immersed in a Viscous Fluid.—Dr. G. B. Jeffery: The Rotation of Two Circular Cylinders in a Viscous Fluid.
LINNEAN SOCIETY OF LONDON, at 5.—R. E. Holttum: The Flora of Greenland.—J. Walton: The Ecology of the Flora of Spitzbergen. —Sir W. A. Herdman: "Spolia Runiana," V.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—W. D. Douglas: Testing Aircraft to Destruction.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Discussion on Starters: Introductory Papers by C. H. Wordingham: The B.E.S.A. Specifications for Starters.—J. Anderson: Electric Motor Starters.—W. Wilson: Some Notes on the Design of Liquid Rheostats.
CHEMICAL SOCIETY, at 8.
ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—G. Luker: A Wandering Silk Suture Removed from the Urethra as a Sequel to Cæsarean Section.—Dr. C. D. Lochrane: Decidual Reaction in Adenomyoma of Vaginal Wall.—Dr. R. A. Gibbons: Sterility with Reference to the State.

FRIDAY, MARCH 3.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.—E. M. Woodman, Dr. Reginald Morton, and others: Discussion on The Treatment of Malignant Growths of the Nasal Accessory Sinuses.
ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion on The Depth of Earthquake Foci. Chairman: Sir Frank Dyson. Speakers: Prof. H. H. Turner, Dr. J. W. Evans, Dr. Dorothy Wrinch, Dr. H. Jeffreys.
INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—A. P. Bale: Spiral Bevel *v.* Straight-tooth Bevel.
JUNIOR INSTITUTION OF ENGINEERS, at 8.—E. T. Elbourne: Factory Administration.
ROYAL SOCIETY OF MEDICINE (Anæsthetics Section) (Annual General Meeting), at 8.30.—Dr. Z. Mennell: Anæsthesia in Intracranial Surgery.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. C. M. Wenyon: Microscopic Parasites and their Carriers.

SATURDAY, MARCH 4.

INSTITUTION OF LOCOMOTIVE ENGINEERS (at Caxton Hall, S.W.1), at 2.15.—J. Clayton: Lubrication of the Modern Locomotive.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radio-activity (1).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

THURSDAY, FEBRUARY 23.

INFANTS' HOSPITAL (Vincent Square, S.W.1), at 4.—Dr. W. M. Feldman: The Physiology and Pathology of the New Born; Initial Loss of Weight: Icterus Neonatorum.
UNIVERSITY COLLEGE, at 5.15.—Prof. J. E. G. de Montmorency: Welsh and Irish Tribal Customs (3).
KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (6).
ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN (Leicester Square, W.C.2), at 6.—Dr. W. Griffith: The Bullous Eruptions (Chesterfield Lecture).
BIRKBECK COLLEGE, at 8.—G. Bernard Shaw: The Failure of Education.

FRIDAY, FEBRUARY 24.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (6).
CANCER HOSPITAL (Fulham Road, S.W.3), at 4.—W. E. Miles: Cancer of the Rectum.
UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (3).
TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (5).

SATURDAY, FEBRUARY 25.

LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (6).
HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. W. A. Cunnington: Man's Sphere in Savage Africa.

MONDAY, FEBRUARY 27.

CITY OF LONDON (BOYS') SCHOOL (Victoria Embankment), at 5.30.—Miss Rosa Bassett: The Dalton Plan of Self-education (4).

TUESDAY, FEBRUARY 28.

IMPERIAL COLLEGE—ROYAL SCHOOL OF MINES, at 5.30.—Col. N. T Belaiew: The Crystallisation of Metals (2).
LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 6.—Sir Josiah Stamp: The Administrative Factor in Government (3).

WEDNESDAY, MARCH 1.

EAST LONDON COLLEGE, at 4.—Prof. F. E. Fritch: Certain Aspects of Freshwater Algal Biology (3).
LONDON (R.F.H.) SCHOOL OF MEDICINE FOR WOMEN, at 5.—Dr. H. H. Dale: Some Recent Developments in Pharmacology (2).
HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (6).
UNIVERSITY COLLEGE, at 8.—The Current Work of the Biometric and Eugenics Laboratories (3).—Dr. P. Stocks: Scheme of Anthropometric Measurements in the Biometric Laboratory.

THURSDAY, MARCH 2.

INFANTS' HOSPITAL (Vincent Square, S.W.1), at 4.—Dr. W. M. Feldman: The Physiology of the Infant (1).
SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. L. D. Barnett: The Hindu Culture of India (1).
UNIVERSITY COLLEGE, at 5.15.—Prof. J. E. G. de Montmorency: Welsh and Irish Tribal Customs (4). At 5.30.—Dr. C. Pellizzi: Giardano Bruno in Inghilterra (In Italian).
KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (7).
ST. JOHN'S HOSPITAL FOR DISEASES OF THE SKIN (Leicester Square, W.C.2), at 6.—Dr. W. Griffith: The Treatment of Skin Diseases (Chesterfield Lecture).
CIVIC EDUCATION LEAGUE (at Leplay House, 65 Belgrave Road, S.W.1), at 8.15.—Miss Margaret Tatton and others: Discussion on Art in Relation to Education.

FRIDAY, MARCH 3.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (7).
UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (4).
TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. Crichton Miller: The New Psychology and its Bearing on Education (6).

SATURDAY, MARCH 4.

POLYTECHNIC (Regent Street, W.1), at 10.30 a.m.—Prof. A. Harden: Vitamins.
LONDON DAY TRAINING COLLEGE, at 11 a.m.—Prof. J. Adams: The School Class (7).
HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: Dragon-flies and their Life-history.

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NATURE

THURSDAY, MARCH 2, 1922.

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Cycles in the Yield of Crops.

NEARLY five-and-twenty years have elapsed since Sir Arthur Schuster, by devising the orderly and comparatively brief process known as the "periodogram method," gave a great stimulus to the investigation of periodicities in natural phenomena. Solar and magnetic phenomena provided the first fields of application, and meteorological data have since been attacked by many investigators. It seems fitting that crops, which are so largely dependent on the weather, should be submitted to the same test.

In the course of last year Prof. H. L. Moore, of Columbia University, published a series of three articles in the American *Quarterly Journal of Economics*, which may be briefly summarised as indicating that, in the periodogram for periods of three to twelve years, there is a marked maximum at eight years in the cycles of a number of crops and corresponding cycles in the production of the raw materials of industry. This periodicity appears to correspond to what is known as the "economic cycle" in trade, and it is suggested that the periodicity in crops is the *generating cycle* of the whole movement—a movement which is very clearly reflected in prices. Prof. Moore's data refer, for the most part, to the years 1882–1918 only, with the exception of Sauerbeck's data for prices in this country, which are available from 1818, and of wheat prices in England, which are utilised for the years 1870–1916. To the latter part of his third article we return briefly below.

In the meantime, in an article published in the British *Economic Journal* for March 1920, Sir William Beveridge suggested, on evidence which, to many readers, did not seem at all adequate, the existence of a period "between 15·2 and 15·4 years." In the same journal for December 1921, a further paper was published in which the original conclusion is completely vindicated. By the aid of overlapping data as to wheat prices in a large number of places in Great Britain, France, Germany, and the Netherlands, an index-number of wheat prices for Western Europe is constructed running from 1500 to 1869. The index-number for each year is then expressed as a percentage of the mean of the thirty-one years surrounding it, and the results are submitted to periodogram analysis over the three centuries 1545–1844, for periods running from two years to thirty-six. Data are also given separately for 1545–1694 and 1695–1844.

For the whole 300 years and for the last 150 years the greatest intensity, taking only integral periods, is at fifteen years, the maximum being well marked; for the earlier 150 years the intensity at 15 (70) is slightly exceeded by the intensity at 11 (76), 13 (80), and 18 (73). Testing fractional periods on the series as a whole, the intensity at 15 (47) is raised to 82 at 15⅓, and to 80 at 15½. The dominant period appears, therefore, to be fairly closely 15·3.

But, Sir William Beveridge suggests in an interesting analysis that follows, the period thus found is probably not a real one—*i.e.* is not the period that exists in the operative cause, the weather. If a certain cycle exists in the weather tending to give, say, abnormally heavy rain at its maximum, it will nevertheless not have any adverse influence on the harvest unless the maximum and its accompanying deluge fall within the limited period of year during which the crop is growing. Hence what will be observed in the crop is not necessarily the period of the weather cycle, but the period in which its maximum tends to recur during the critical months. We have not space to follow the author's reasoning in detail, but it is suggested that there are at least two weather cycles operating, if not four—(*a*) with a period of approximately 4·37 years (30·6/7), which corresponds to a cycle identified by Sir Arthur Schuster in sunspots; (*b*) with a period of about 5·11 years (30·6/6), which has been found in temperature and rainfall records; and two of less certainty, (*c*) with a period of 2·74 years (30·6/11), and (*d*) with a period of 3·71 years, both of which also appear to have been identified in meteorological or astronomical data.

The period observed, it is argued, arises from a temporary compounding of the effects of these four cycles. All four "are due to return to a maximum phase between February and September 1923," and this may mean an exceptionally bad year for harvests in Europe. "In the excessively improbable event of my arithmetical analysis being complete and accurate in every particular," Sir William Beveridge continues

"1923 is destined to repeat something like the experiences of 1315, the year of the worst and most general harvest failure known in European history." To the crowd, if not to the man of science, the fulfilment of a prophecy always seems to give more adequate support to a theory than any number of agreements with past events, and the year 1923 may be awaited with an interest mingled with anxiety. On the face of it, the evidence seems sound, and the reasoning careful and critical.

Sir William Beveridge does not attempt to trace the physical causation of the observed periodicity further than to show that it may be accounted for by cycles already noted in meteorological or astronomical data. The eight-year period gives only a small maximum in his periodogram with an intensity of 12. Years after 1844 were apparently omitted in part because during the nineteenth century the character of the curve visibly alters, the "credit cycle" acting as a "disturbing influence." It may, however, be questioned, in view of Prof. Moore's work, whether the credit cycle can be treated in this way as an extraneous disturbing cause. An eight-year cycle, as he says, was isolated in the barometric pressure of the United States, and has also been traced in rainfall, and these cycles appear to be congruent with the economic cycle. When Prof. Moore goes beyond this and seeks for a cosmic cycle that may be regarded as the "generating cycle," he lights on an hypothesis for which, we think, a good deal of further evidence will be required before it can win acceptance; it is suggested that the period in question is that between conjunctions of the earth and Venus. No proof, however, is given that the periods coincide with any precision, the periodograms for economic data having been calculated only for integral periods.

Analysis must be carried further before a true consonance of the periods can be predicted with any confidence. The point brought out by Sir William Beveridge, moreover, that the period in the weather may not be that in the yield of the crop, must be borne in mind. If a "maximum" of some kind in the weather is vital to the crop only provided that it occur at some critical period of the year, the determination of this critical period becomes of interest, and we would suggest that such work as that of Mr. R. H. Hooker, of the Ministry of Agriculture, whose presidential address to the Royal Meteorological Society on the correlation in eastern England between yield and the weather in successive months of the year was summarised on p. 193 of NATURE for February 9, might help to elucidate the matter. Crop prediction is a matter of the highest economic importance, and all lines of investigation should be considered together.

A Searchlight on Solids.

Aggregation and Flow of Solids: Being the Records of an Experimental Study of the Micro-structure and Physical Properties of Solids in Various States of Aggregation, 1900–1921. By Sir George Beilby. Pp. xv+256+34 plates. (London: Macmillan and Co., Ltd., 1921.) 20*s*. net.

THIS is a book that will hold a true child of science like any fairy-tale, and it would be difficult to overstate its fascinating interest. In form, in substance, and in all its auspices it is so highly individual. It is a story, a connected story, of the leisure pursuits of one of our leading and most enlightened industrialists, who for many years, and pre-eminently in the stress of war, has rendered great

FIG. 1.—Globules of zinc dust picked up on the edges of a thin steel blade (×60). From "Aggregation and Flow of Solids."

services to his country. But it is a record that would adorn a life wholly devoted to the pursuit of science.

All who are seriously concerned with physical or chemical science must know something of the contributions which Sir George Beilby has made to the subject dealt with in this book, but the rush of scientific discovery makes it very difficult to realise the full sweep and significance of much that is going forward. Probably every one knows that Sir George Beilby has demonstrated the existence of a vitreous state in metals and other solids where that state had never been suspected, and to most of us he has become permanently "featured" on the transparent *surface film* of polished solids.

In his papers from time to time he has disclosed in some degree the theoretical accompaniment and the connecting threads of his experimental work, but it is probable that few will have seen the extraordinary breadth and comprehensiveness of the ideas which have developed as the work proceeded, or have realised

the extent of their implication in matters of great scientific and practical importance.

The work under notice now tells the whole tale in a form which leaves nothing to be desired, and adds at least one new chapter. It is not difficult to understand how much it must have cost of resolution and hard labour to bring to its present form the vast amount of material that had accumulated in Sir George Beilby's hands, and we must all be grateful to Sir Herbert Jackson, whose persuasiveness brought Sir George Beilby to the point of setting out on his task, and whose help, along with that of Mr. W. D. Haigh, is very gratefully acknowledged by the author. "I unhesitatingly say," he states, "that without his (Mr. Haigh's) constructive skill and insight the work would not have been accomplished." And we may add that no one more than Sir Herbert Jackson was in a position to appreciate the importance of Sir George Beilby's work.

FIG. 2.—Crystalline antimony polished by emery and rouge and etched with potassium cyanide, showing film of flowed metal covering pits. From "Aggregation and Flow of Solids."

The letterpress extends over some 250 pages, clearly printed and in every respect easily readable. The concluding part consists of thirty-four beautiful reproductions of a series of figures, nearly all photographic. Not one of them is uninteresting, and most of them are remarkable. In the letterpress the topics dealt with in sequence are the following: Microscopic methods and measurements; surface tension films in liquids and solids; the varied ways in which aggregation takes place; cohesion among minute solid particles and between these particles and flat surfaces; polish, the result of surface flow; the crystalline and vitreous states in solids; influence of the crystalline and vitreous states on the physical and mechanical properties of ductile metals; influence of the crystalline, mobile, and vitreous states on the flow of rocks and ice; molecular pulsation cells: a tentative hypothesis; extension of Faraday's work on the optical and other characteristics of thin metal leaves; phosphorescence of crystals effected by the change from the crystalline to the vitreous state.

The general nature of Sir George Beilby's work can probably be best understood by thinking of the conditions under which it was carried out. We have to picture a man of scientific taste and talent, whose lot has been cast in the industrial world, eager to devote his leisure to the advancement of fundamental knowledge and compelled to select a topic that can be cultivated experimentally under home conditions, that do not give any very exceptional facilities for experimental work. Under these limits, what better than to take up the study of some topic of micro-chemistry or micro-physical chemistry? Able to provide himself with the best appliances for his purpose, and skilled in the manipulative art of the chemist, he develops a highly special technique, and with all these resources applies himself to particular problems of his subject. The result is a series of refined observations and delicate manipulations which has disclosed many things never seen before and established many new facts about the structure and behaviour of solids.

It is really very difficult to give a summary of what is contained in this book. It would be rather like writing a short paragraph summarising the incidents of an Antarctic explorer's voyage of discovery. No doubt it is possible to say, in a word, that the centre of Sir George Beilby's doctrine is the vitreous film of solids, but the great interest of the book lies in the record of successive experimental steps by which the facts have been established and amplified. To the student of molecular physics, the metallurgist and engineer, the geologist, the fine artificers of glass and metal, the records have something of first-rate importance to say.

The present writer is probably not singular in having felt surprise on first learning that the final perfect polish of glass or metal was produced by the use of an abrading agent. One could understand the finer and finer scratches of grinding giving a greater and greater smoothness, and it was possible in the

mind to conceive the *ad infinitum* refining of scratches to the attainment of a perfect sheen. But in actual practice, with a last abrasive even so fine as particles of rouge, it seemed as if there must somehow be a jump at the end between these earthy scratches and the perfect polish of speculum or plate glass. The practical attainment of such a polish seemed much

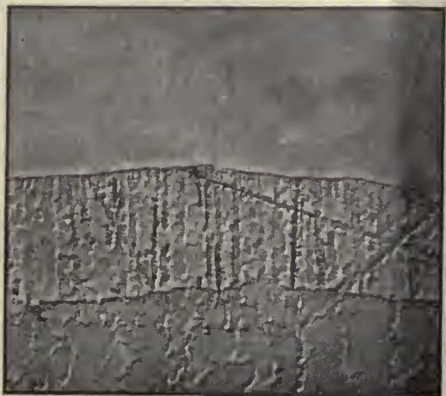

FIG. 3.—Etched calcite surface showing the untouched skin and the under surface at 500 and 1000 $\mu\mu$. From "Aggregation and Flow of Solids."

more easily understood when a custodian of some of the finest old silver at Cambridge, on being asked how the brilliance was produced, simply exhibited the flesh side of an ample thumb, with a gesture and mien indicative of a *flattening* pressure exerted steadily through the ages. Sir George Beilby now tells us, and it is a relief to know it, that the microscopically differentiable particles of rouge are smaller than we thought, that they are also much harder, and that when they are spread over a leather they present a layer such that when the leather is passed over the glass or metal surface, this is *seized* as a whole, the mobility of a liquid is temporarily produced, and when the leather has passed, a film is left with all the qualities of matter that has set like melted glass. Not only so, but "whilst to produce 'mass flow' in the hardened steel of which a razor is made a differential pressure of hundreds of tons per square inch would be required, yet the 'surface flow' necessary to keep the edge of the razor in perfect cutting condition can be effected by lightly stropping the blade on the bare hand a few times daily, before and after use!"

These examples are perhaps sufficient to indicate why and how this work on the surface leads to a study of the hard and soft state in metals, the flow of rocks and ice, the phosphorescence and triboluminescence of solids, and many other things besides.

A word must be said about the magnitudes dealt with in the investigations. The study of a calcite surface will suffice as an illustration :—

"When a condensed beam of sunlight was used to give oblique illumination of the surface, it was possible to detect the effect of a drop of acid which contained only 0·000125 per cent of HCl. The depth of the layer removed did not exceed 0·62 $\mu\mu$. . . . If it is correct to assume that the solvent effect of the acid was uniformly distributed over the whole surface of the pit, then it follows that a roughening of the surface not more than two molecules in depth has been detected." Again, "the mechanical disturbance caused [on calcite] by the polishing agent penetrates to a depth of 500 to 1000 $\mu\mu$."

The frame of reference of Sir George Beilby's thinking has been almost wholly that which preceded subatomism. In a short chapter he sketches his tentative working hypothesis of molecular "pulsation cells." Of this it must suffice to say that it has clearly served its purpose, for it has worked—it has led to a solid output of new knowledge. "Cohesion" is isolated in the old way as a force *sui generis*, and a fine picture is made of cohesion holding matter together in a dead world until there comes the advent of heat "like the first breath of approaching spring into the sleeping buds." Sir George Beilby has brought his rich gift of facts up to the frontiers of the newer physical

FIG. 4.—Microscopic crystal of antimony. From "Aggregation and Flow of Solids."

science. It must obviously engage the interest of those on the other side. There are especially to be mentioned the Braggs, the work and views of Langmuir, and the new light on lubrication coming from W. B. Hardy's experiments. But whatever may be added, the facts remain as a remarkable addition to scientific knowledge.

In conclusion, one or two suggestions may be made.

As to faults, there is need of revision at the beginning of the book in reference to the characteristic of the boiling-point. There is no index, and though one can see the peculiar difficulty of indexing this book, the omission is an inconvenience. It seems worth considering whether enlarged copies of the beautiful photographs which illustrate the book might not be issued so that they could be framed and hung on class-room walls.

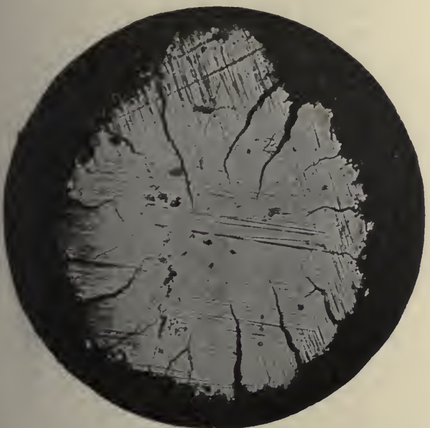

FIG. 5.—The crystal of Fig. 4 flattened by a single blow from a small drop-hammer; the thin plate was in a highly strained condition and the cracks developed in 24 hours. From "Aggregation and Flow of Solids."

A last suggestion, offered to teachers, is that this book should be freely prescribed to students of physical science. It seems very important in times with so strong an atmosphere of relativity and with *quanta* to some of us almost more than *suff.*, that students should see how much may still be accomplished by a faithful, indefatigable experimenter, who, with full knowledge, yet without prejudice, will scrupulously examine what lies positively and immediately in front of him.

A. SMITHELLS.

Pictish Stone Circles.

On Some Antiquities in the Neighbourhood of Dunecht House, Aberdeenshire. By the Rt. Rev. Dr. G. F. Browne. Pp. xiv+170+63 plates. (Cambridge: At the University Press, 1921.) 63*s.* net.

DUNECHT HOUSE, Aberdeenshire, became known to science by the researches of Drs. Copeland and Lohse at an observatory established there by the Earl of Crawford. The district so thoroughly examined by the distinguished author of this superb book is that of Lady Cowdray's Scottish estate and the immediate surroundings, a district known as "'twixt Don and Dee."

Confining my remarks to the subject which is given the largest space in the book, there is in the district of Dunecht a "large number of stone circles unique in type" (p. 1), the characteristic feature being a tangential alignment, generally in the south-west quadrant, made by a recumbent stone and its upright flankers. Of these circles Sir Norman Lockyer examined twenty-nine, and in fifteen instances he found a clock-star alignment at right angles to the recumbent stone. He discovered, in fact, the key to this unique type of circle. In my opinion, the glory of Dr. Browne's work on the Dunecht circles shines in the fact that in it the typical Pictish temple thrown open by Sir Norman Lockyer may now be inspected to the smallest detail.

A happy inspiration led the author to appeal to the Principal of the University of Aberdeen for a survey to be made of three circles, using the recumbent stone and flankers as a tangential base line, and measuring the alignment made by each stone with the middle of the recumbent stone. The survey was made by Drs. Fyvie and Geddes, and the circles were those of Midmar, Castle Fraser, and Sin Hinny (Sunhoney). It is most fitting that the three plans form Plate I.

Realising the importance of Dr. Browne's contribution to science, I have examined the seven plans of circles given in the book, and find that the alignments of the other four are also to be interpreted from the recumbent stone, the evidence being alignments in pairs at right angles to each other.

The whole truth, partly discovered by Sir Norman Lockyer, seems to be this: In the Pictish type of circle all alignments must have been originally made in pairs at right angles to each other. Finding this first, or fundamental, principle of circle-building fully established in each of the seven cases examined, I have applied that principle to test the present condition of each circle. By such a test six circles are found to be defective, and I think it is quite possible, theoretically, to restore the defective parts.

It is most fortunate that one circle is perfect according to the revealed Pictish standard, and that is Auchquhorthies (p. 69). It consists of a recumbent stone and flankers and nine other stones (the three stones on the inner side of the recumbent stone had probably some supplementary use). The outer sides of the flankers are aligned with the recumbent stone, but on their inner sides they have separate alignments which rank in the rectangular scheme of the circle and, with those of the nine out-lying stones, have a common base at the middle of the recumbent stone. The twelve separate alignments made by the twelve stones of the circle proper present six pairs of complementary measures. To obtain this result it is necessary

to measure the angular width of each stone from the observational base, and both the side measures and the average measures thus obtained should be studied. The following are averaged measures :—

1.	N.W. 72° S.E. (base line) . .	N. 19° E.
2.	East point	N. 2° E.
3.	N. 74° E.	N. 13° W.
4.	N. 63° 15′ E.	N. 28° W.
5.	N. 48° 45′ E.	N. 42° W.
6.	N. 33° 45′ E.	N. 57° W.

The average angle for the series is about 89° 30′. In two instances, side alignments form perfect right angles. In other instances it seems highly probable that the angular width of a stone was utilised for two alignments. Thus, of the side measures averaged as N. 42° W., the one on the north side of the stone is 38° and the one on the south side is 46°. By the table of solstitial azimuths for lat. 57° N. given on page 381 of "Stonehenge" (sec. ed.), 46° would be sunset at the summer solstice with a horizon of 2° high, and 38° would be sunrise at the winter solstice with the horizon a trifle higher.

It is a great thing to know that the position of each stone in a Pictish circle is, or was intended to be, at right angles to some other position. If the observational base of other types of circles could be discovered it is extremely likely that the same fundamental principle would be found applied. Given a number of rectangular alignments, with horizon measures, it is practically certain that for each circle a star cast, like that of actors in a drama, could be made out, making the determination of the period involved comparatively easy.

Without horizon measures, the solar alignments of the Dunecht circles are easily recognisable. Judging by the one complete circle described, we are warranted in assuming that both the May-year and the solstitial year are provided for. Regarding the base line as of first importance, we have May-year, solstitial, and stellar circles of one and the same cultural type. For an explanation of this variety in unity we need, for one thing, a new survey of all the Pictish circles on the plan suggested by Dr. Browne. JOHN GRIFFITH.

Thorpe's Dictionary.

A Dictionary of Applied Chemistry. By Sir Edward Thorpe. Assisted by Eminent Contributors. Vol. 2: *Calculi to Explosion.* Revised and enlarged edition. Pp. viii + 717. (London: Longmans, Green and Co., 1921.) 60*s.* net.

THE "Dictionary of Applied Chemistry" has now become so indispensable to workers in pure as well as in applied chemistry that it can be stated without fear of contradiction that no library either in the university or in the works can be regarded as complete without it. The appearance of the second volume of the new edition following so closely on that of the first will therefore be welcomed, and will be taken as an indication that the remaining volumes will be published with equal rapidity. The first feature which is noticeable in the new volume is the decrease in size and the increased handiness compared with the corresponding volume of the last edition. This result has been attained by reducing the number of pages by about eighty and by using a thinner paper, the general effect being to produce a volume which can be held in the hand readily without fatigue. It follows, although it is not specifically stated, that the publishers intend to issue the dictionary in six or more volumes instead of the five which have hitherto sufficed.

The subject-matter in the volume under review therefore comprises part of that issued in vol. 1 of the last edition and part of that which appeared in vol. 2. The last edition of the dictionary was reprinted in 1917 from the revised edition of 1912, but despite the comparatively short time which has elapsed—a period during which little scientific work was done—it has been found possible to introduce much new matter; this is shown by the fact that the subjects dealt with in the present volume occupy 717 pages, whereas in the last edition they filled 547 pages only.

On the whole there is little call for criticism. The article on carbohydrates—one would like to see this name abandoned because, obviously, the sugars of the rhamnose group, $C_6H_{12}O_5$, are not carbohydrates—by E. F. A. is altogether admirable and stands out by itself as an illustration of what can be done by a master of his subject to make a highly complex chapter in organic chemistry interesting to expert and lay-reader alike. On the other hand, the article on camphor is very disappointing. It is difficult to understand what useful purpose can be served by publishing an article on the chemistry of this substance which does not contain one single graphic formula. Had this edition been published thirty years ago there might have been some justification for the inclusion of this article. The articles on carbolic acid and cellulose remain practically unaltered; it is doubtless too soon to expect to find a full description of the many important uses to which these substances and their derivatives were put during the war.

The article on chlorine has been entirely rewritten by H. B., and is an exhaustive account of this element. It contains a vigorous reference to the use of poisonous substances by the Germans during the war, and gives a list of some of those employed. One would like to have seen, however, an article on chemical

warfare (it is not too late, because it can still come under Warfare) in which this important subject would receive full treatment and in which the activities of British chemists would obtain recognition. It is a curious fact that the need for such an article was emphasised by Sir Edward Thorpe himself in the review he wrote on the book published recently by Prof. Moureu in which this distinguished French chemist describes the activities of his own countrymen. In the next edition the article on chemical warfare might well follow that on chemical affinity.

One is glad to note that the old article on vegeto-alkaloids is to be abandoned, and the different subjects are to be treated under their own heads; thus there is an excellent article on cinchona alkaloids by B. F. H. and O. C., which gives a full account of these important substances. The articles on the natural colouring matters and allied substances by A. G. P. are especially noteworthy, as are those on certain drugs, which fall within this section, by G. B. It is articles such as these which render the dictionary indispensable to the research worker, because they give in a clear and concise manner all the essential details of the chemistry of the substances dealt with and do not confuse the issue by a mass of irrelevant data. It is usually difficult to find information of this kind elsewhere.

Of the longer articles on subjects of general interest, those on carbon, coke manufacture, and recovery of by-products by W. A. B. and E. R., copper cyanides by T. E., distillation by S. Y., and gaseous explosion by W. A. B. and R. V. W., have been brought up to date but otherwise retain the features which have rendered them so useful in previous editions.

There are some completely new articles, and, of these, that on colour and chemical constitution by E. R. W. is particularly interesting. Most chemists will be familiar with the book on this subject which the same author contributed to the series of monographs on industrial chemistry edited by Sir Edward Thorpe, and although they may not all agree with many of the views expressed therein, they cannot but acknowledge that the account given is a fair and clear description of our present position in regard to this very complex question. The present article may be described as a *précis* of the book, and is well worth perusal. Another new article is that by J. N. F. on the corrosion of metals. This is a subject which this chemist has made his own, and there are few who can write on it with greater authority. It is well written, and presents the subject from a point of view which cannot fail to be interesting. The article on dyeing remains much the same as in former editions. One wonders if the tables for detecting colours on the fibre, which occupy fifteen pages, are really worth the space. It may be noted in passing that although the excellent article on cholesterol is signed I. S. M., the name of this distinguished lady does not appear among those of the eminent contributors at the commencement of the volume.

J. F. T.

A New View of Fertility.

The Law of Births and Deaths: Being a Study of the Variation in the Degree of Animal Fertility under the Influence of the Environment. By C. E. Pell. Pp. 192. (London: T. Fisher Unwin, Ltd., 1921.) 12*s*. 6*d*. net.

IN the issue of NATURE for September 22, 1921, p. 105, appeared an article on "Causes of Fluctuation of the Birth-rate," the statements and speculations in which are usefully supplemented in the present volume, which is a valuable contribution to the discussion of this important problem. The main thesis of the book is that the decline of the birth-rate is not explicable on the hypothesis that it is due to the deliberate evasion of child-bearing, but that it can be explained as the result of a natural law the function of which is to adjust the degree of fertility to suit approximately the needs of the race. Much ingenuity is displayed in arriving at the conclusion that the response to the action of the environment in the degree of fertility bears an inverse proportion "to the intensity of the nervous charge," and that the principle involved is a law governing the union of sperm cell and ovum. Unlike Doubleday, whose theory was that a plethoric condition of the organism is unfavourable to fertility, Mr. Pell regards food as only one factor and thinks there is good reason for believing that cerebral development and mental activity are far more important than the supply of food. In this respect his theories approximate to the well-known views of Herbert Spencer as to the inverse relationship between ability to maintain individual life and the ability to multiply.

The arguments by which the above propositions are supported are ingenious and suggestive, although occasionally weak and doubtful points are presented with as great confidence as strong arguments. Thus the author argues from very imperfect data that the sale of contraceptive articles does not take place on a scale large enough to account for the lowered birth-rate, and he assumes the accuracy of the limited data available as to sterility and small families in circles where contraceptive methods are or are not practised. Such data would need to be corrected for age distribution of the married couples under comparison and for the duration of marriage before valid inferences could be drawn. Even then it would scarcely be practicable

to correct for the varying prevalence of gonorrhœa, a chief cause of sterility, and of syphilis, a chief cause of still-births and miscarriages.

On the other hand, the author makes valuable use of illustrations given by Darwin and others of the varying fertility of animals under domesticated conditions. It is evident that there is in this direction a line of valuable investigation into the laws governing fertility which has hitherto scarcely been explored. The evidence is none the less valuable because throughout this book it is pressed into service in support of the author's hypothesis that increasing nervous energy, high feeding, and diminished physical labour reduce fertility, whether in mankind or in the highly bred racehorse.

Travel and Exploration.

(1) *Hints to Travellers. Scientific and General.* Tenth edition. Revised and corrected from the ninth edition, edited for the council of the Royal Geographical Society. By E. A. Reeves. Vol. 1, *Surveying and Practical Astronomy.* Pp. xv+470. Vol. 2, *Meteorology, Photography, Geology, Natural History, Anthropology, Industry and Commerce, Archaeology, Medical, etc.* Pp. vii+318. (London: The Royal Geographical Society, 1921.) 21*s.* net (two vols.).

(2) *Camping and Woodcraft: A Handbook for Vacation Campers and for Travellers in the Wilderness.* By H. Kephart. New edition, two volumes in one. Pp. 405+479. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1921.) 16*s.* net.

BOTH these books are written for the traveller, but they look upon his needs from different points of view. In their scope and appeal, no less than in their style, they differ widely. The first may be said to minister to the intellectual needs of the traveller, the second to his material wants.

(1) "Hints to Travellers," which now reaches its tenth edition, has been known for many years as an almost indispensable volume for the traveller who aims at doing any useful scientific work. Mr. Reeves's volume on surveying and practical astronomy must have found its way into more remote corners of the world than any other book except the *Nautical Almanac.* The present edition has been revised, particularly as regards the second volume, but the general plan of the book remains unchanged. The addition of a few pages devoted to marine invertebrates would not be amiss in the natural history section, and might help to direct attention to an aspect of collecting which many travellers are prone to overlook.

(2) Mr. H. Kephart's aim is to teach the traveller how to live rather than to take observations and record facts. The two volumes, which are bound together, deal respectively with camping and woodcraft. They have grown from an earlier single volume which was published in 1906 and was devoted entirely to travel in the wilds. The author now appeals to a wider public, and devotes much attention to the growing class of holiday-makers who camp, not from necessity, but by choice. For the benefit of the latter there are chapters on fixed camps and camp furniture. The chapter on camp cookery is most elaborate. Mr. Kephart expects campers to live well—his dishes and recipes take us far from the simplicity of oatmeal, bacon, and tea, which are so often the staples of camp life—but evidently the amateur camper in America does not risk any hardship or privation. The chapters on tents, bivouacs, clothing, camp-fires, packs, and cave exploration, to mention only a few, are full of useful hints, even if some of them are too obvious to merit inclusion. There are useful remarks on axemanship, and well-illustrated notes on knots and hitches. The notes on accidents and emergencies are most practical. Altogether Mr. Kephart's book makes fascinating reading, and, even if primarily designed for life in the forests of North America, it should prove useful to campers all the world over, and should certainly find a place in every boy scout library.

R. N. R. B.

Our Bookshelf.

Introduction to Textile Chemistry. By H. Harper. (Life and Work Series.) Pp. ix+189. (London: Macmillan and Co., Ltd., 1921.) 3*s.* 6*d.*

LARGE extensions in the work of elementary education, provided in the Education Act of 1918, have given rise to the necessity for providing books of a new type. Whether the increased facilities for education offered by the Act are ever to materialise cannot yet be stated, but the series in preparation by Messrs. Macmillan and Co., three volumes of which have been issued, seems to provide a type of book which should have a very beneficial influence on education beyond the elementary-school standard. One of the arguments against education is that it unfits the "worker" to perform his daily routine. Even the least intelligent critic would probably admit that a workman is not less useful when he knows something about the material he handles and the machinery which manipulates it. The "Life and Work Series" will assist education which, without being narrowly utilitarian, takes as a basis the life and work of man—a wide enough scope for any educator.

The present volume is evidently the work of an experienced teacher. The reviewer has taught students of a textile centre on similar lines, and he is of opinion that the book should be most successful. Wool has, no doubt on account of the locality of the author's school, a more prominent place than cotton, which will make

the book less useful in Lancashire. In the reviewer's opinion it would be better to have a separate book dealing with cotton in more detail. The paper, printing, and illustrations are excellent.

Ancient Tales from Many Lands: A Collection of Folk Stories. By R. N. Fleming. Pp. 193+ix plates. (London: Benn Bros., Ltd., 1922.) 10s. 6d. net.

IN bringing together this collection of tales Miss Fleming has cast her net wide. Japan, China, India, North America, Egypt, Mesopotamia, ancient Greece, and the British Isles, to name only some of the sources, have contributed to a whole which, viewed merely as a collection of folk-tales, is charming both in subject-matter and in style. The author has, however, had more in view than to provide a pleasant pastime for an idle hour. Her aim has been to present in these traditional stories, in which the spirit of the original is preserved as nearly as possible, a picture of the culture and modes of thought of primitive and early historic peoples in a form that can be utilised and interpreted by the teacher, whether of history or social geography, and at the same time appreciated by the child. Miss Fleming adds in an appendix three essays in which she expounds her philosophy of the use of the folk-tale in education and the principles of selection. If any further indication were needed of the thought, wide reading, and experience which have been laid under contribution in the making of this book, it would be afforded by these essays.

Confectioners' Raw Materials: Their Sources, Modes of Preparation, Chemical Composition, the Chief Impurities and Adulterations, their More Important Uses, and Other Points of Interest. By J. Grant. Pp. viii+173. (London: Edward Arnold and Co., 1921.) 8s. 6d. net.

THE author of this little volume set himself no light task in attempting to provide a handbook suited to the needs of students taking organised courses of instruction in the principles governing confectionery practice. These students usually possess little or no knowledge of elementary science, while, on the other hand, their subject enters many and varied fields of scientific inquiry with which it is by no means easy to deal in simple language. In our opinion the author has skilfully compressed into a small volume and in a readable form a mass of information, hitherto available only in a scattered and relatively difficult literature, which should be of much assistance to the students concerned. A useful introduction is followed by chapters on alcoholic beverages used as flavouring agents, carbohydrates, fruits, essential oils, eggs, and egg products; there is also a useful outline of the methods employed in the analysis of raw materials. The book is by no means without imperfections. The sections dealing with botanical subjects need revision by a botanist, whose recommendations would certainly include suggestions for alternatives to some of the illustrations on p. 101. Again, a bibliography which gives as consecutive entries "Bolton and Revis—*Fatty Foods*," and "Britannica—*Encyclopaedia*," clearly needs drastic revision. Further, the sub-title could easily be improved.

Cocoa. By Edith A. Browne. (Peeps at Industries.) Pp. viii+88. (London: A. and C. Black, Ltd., 1920.) 2s. 6d. net.

WE have had much pleasure in reading this well-illustrated little book, which is a notable addition to a useful series. Miss Browne, who has first-hand knowledge of the Gold Coast, takes her readers on a personally conducted tour through the cocoa-growing districts of the Gold Coast Colony and Ashanti, which, as most people know, now form the premier cocoa-growing region of the world. The information conveyed in this interesting fashion is complete, accurate, and well arranged, and is supplemented with admirable glimpses of West African life. Balance is given to the book by an account of cocoa-growing in other countries, followed by a description of the manufacture of cocoa products in two well-known English factories. Miss Browne finds opportunity to warn the West African cocoa industry of the potentialities of South American cocoa-growing countries now deprived of their former pride of place. The warning is well timed and merited, not solely on the grounds mentioned by the author.

A Star Atlas and Telescopic Handbook (Epoch 1920) for Students and Amateurs. By A. P. Norton. Pp. 34+16 maps. (London: Gall and Inglis, 1921.) 10s. 6d. net.

A NEW edition of this useful atlas and astronomical handbook has been published. The maps are clearly printed on a scale of 8° to the inch, and they include stars down to the sixth magnitude, with many fainter objects of interest. The letterpress contains an explanation of all ordinary astronomical terms and much information on both the solar and the stellar systems, together with hints on the use and care of the telescope. There is a clear lunar map, with the names of the principal formations.

A few errata may be noted: on p. 6, along the circles of 6h. and 18h. R.A. declination and latitude have the same direction; on p. 10 the annual P.M. of Groom. 1830 is 7″, not 17″; the magnitude of the Barnard star in Ophiuchus is 10, not 13; and on p. 11 the object entered in the nova list at the date A.D. 389 was certainly a comet and never went near the constellation Aquila. The information given, however, is full and accurate with very few exceptions.

A. C. D. C.

The Practical Electrician's Pocket-book for 1922. Twenty-fourth annual issue. Edited by H. T. Crewe. Pp. lxxxiii+558+54. (London: S. Rentell and Co., Ltd., 1922.) 3s. net.

WE can recommend this pocket-book to all who are practically engaged in any of the industries in which electricity is used. This edition has been revised and contains new sections dealing with tungar rectifiers, railway signalling and current limiters. The latter are devices which either cause the consumer's lamps to flicker in an intolerable way or to become dim if he tries to take more than his permissible current.

The Age of Power: A First Book of Energy, its Sources, Transformations, and Uses. By J. Riley. Pp. viii+248. (London: Sidgwick and Jackson, Ltd., 1921.) 4s. net.

DESIGNED originally for use in continuation schools,

this book will be found equally suitable for the middle forms of secondary schools. Containing, as it does, excellent descriptions of the mode of working in windmills, the steam engine, the internal combustion engine, hydraulic, steam, and internal combustion turbines, etc., it cannot fail to interest boys and to increase their interest in their physical studies. There is enough, but not too much, speculative matter included to stimulate the thoughtful reader. We can thoroughly recommend the volume as providing a useful addition to the ordinary school course.

An Introduction to the Physics and Chemistry of Colloids. By E. Hatschek. (Text-Books of Chemical Research and Engineering.) Fourth edition, entirely rewritten and enlarged. Pp. xiv+172. (London: J. and A. Churchill, 1922.) 7*s.* 6*d.* net.

MR. HATSCHEK'S book is one of the best introductory text-books on the subject in any language, and is widely appreciated. The present edition has been rewritten and enlarged, and embodies much of the recent work on the subject. It should be in the hands of all students of chemistry, and for this reason it is much to be regretted that the price is not lower.

The Manufacture and Uses of Explosives, with Notes on their Characteristics and Testing. By Dr. R. C. Farmer. (Pitman's Technical Primer Series.) Pp. xii+116. (London: Sir I. Pitman and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

ALTHOUGH interest in the military applications of explosives has probably waned to a considerable extent in most countries, it is perhaps not generally realised what an important part these products of chemical invention play in the arts of peace. The name of the author of this small book is sufficient to guarantee the accuracy of the information contained in it, and it is only necessary to state that Dr. Farmer has compressed into about a hundred small pages a surprising amount of up-to-date material. The style is easy, but the treatment is such that the book is far from being merely a "popular" account of the subject: it is a small encyclopaedia, which may be read with advantage by all students of chemistry as well as by those more directly interested in the manufacture and uses of explosives. The very important source of sulphur at Louisiana should have been mentioned on p. 37.

Directive Wireless Telegraphy: Direction and Position Finding, etc. By L. H. Walter. (Pitman's Technical Primer Series.) Pp. xii+124. (London: Sir I. Pitman and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

IT is now thirteen years since Bellini and Tosi read their paper on "A Directive System of Wireless Telegraphy" to the Physical Society of London. Although Marconi and Fleming had previously done good work on directive radio-telegraphy, it was this paper that first showed British physicists how directive signalling could be obtained by using a fixed aerial and only rotating a small coil of wire. The method, however, lay almost dormant until the war proved its great practical utility. Mr. Walter was one of the pioneers of the Bellini and Tosi system, and in the volume under notice a *résumé* is given of most of the useful practical information available. The author has utilised much of the theory recently published by the Bureau of Standards and by the Signal Corps of the United States War Department. The mathematics given is of the most elementary description, and will be readily understood by every physicist and engineer. We can commend this book.

Fuel and Lubricating Oils for Diesel Engines. By W. Schenker. Pp. xii+114. (London: Constable and Co., Ltd., 1921.) 15*s.*

THE title of this book is apt to convey a wrong impression, as its contents in the main are of a general character, and not specially devoted to Diesel engines. There are three sections, the first of which deals with the origin and preparation of various kinds of fuel oils, with special reference to the varieties which may be used for Diesel engines; the second section treats very briefly of lubricating oils; whilst the third consists of a description of the commercial tests applied to these oils. The book would have been of greater service to British consumers of oil had the author included a fuller account of the methods of testing and forms of specification used in this country instead of confining himself to Continental practice in these particulars. Thus Redwood's viscometer, the British standard instrument, is dismissed in a dozen lines, and Abel's flash-point apparatus is not mentioned. Descriptions of other appliances are sometimes too meagre, the bomb calorimeter being given only eleven lines, whilst a purifying apparatus, illustrated on p. 66, is entirely undescribed in the text. In spite of these drawbacks, however, the book contains much useful information of a practical kind. C. R. D.

The Wonder Book of Science. By J. H. Fabre. Pp. 287. (London: Hodder and Stoughton, Ltd., n.d.) 8*s.* 6*d.* net.

THE object of Fabre in writing the series of essays under notice was to impart general knowledge about things that are familiar to the eyes, though not necessarily to the understanding. The first seven essays deal with insect-life, and these are followed by a number on birds, on some of the facts of plant-life, on the various forms of water and the application of steam, on the elementary phenomena of electricity, etc. These essays, which touch on so many subjects, illustrate Fabre's method of arousing the interest of young people in the phenomena around them. In all, forty-eight essays are reproduced, but the name of the translator does not appear.

More Hunting Wasps. By J. H. Fabre. Translated by A. T. de Mattos. Pp. viii+376. (London: Hodder and Stoughton, Ltd., n.d.) 8*s.* 6*d.* net.

THROUGH the energies of the late Alexander de Mattos a number of Fabre's most interesting studies in insect-life have been rendered accessible to the general reader in this country. The present volume consists of fourteen chapters, which complete the essays in the "Souvenirs Entomologiques" devoted to wasps. The remainder have already been translated in two earlier volumes entitled "The Hunting Wasps" and "The Mason Wasps." Two of the essays in this book, which form chaps. 2 and 10, have already appeared in previous translations, while the remainder are rendered in English for the first time. Most admirers of the writings of the French *savant* will welcome the appearance of this book and revel in the fascinating

stories of insect behaviour that are recorded in its pages. Fabre is admittedly a difficult writer to translate, and the charm of his diction only too readily escapes if too much freedom be exercised. Mr. de Mattos's task, therefore, has not been an easy one, but he has carried it out conscientiously and with evident care for accuracy.

A First Book of Applied Electricity. By S. R. Roget. (First Books of Science.) Pp. viii + 143. (London: Macmillan and Co., Ltd., 1921.) 2s. 6d.

THE author has made a very successful attempt to give the elementary principles which underlie the useful applications of electricity and magnetism without worrying the reader with academical definitions and difficulties. The book has what we think is a great merit—namely, that it is entirely independent of the requirements of examinations. It is therefore more interesting than the ordinary treatise, and covers a much wider field.

It can be recommended to the general reader anxious to get an easily acquired, accurate, and useful knowledge of electrical matters. The ordinary student reading for examinations will also find it a useful introduction to more advanced treatises.

Perfumes, Essential Oils and Fruit Essences used for Soap and other Toilet Articles. By Dr. G. Martin. (Manuals of Chemical Technology.—X.) Pp. vii + 138. (London: Crosby Lockwood and Son, 1921.) 12s. 6d. net.

DR. MARTIN's book is of a severely practical character; it contains much information in a very condensed form, and should be useful as a work of reference to those interested in the manufacture of the class of materials of which it treats. A large number of practical recipes is given. The section on analysis, occupying only four pages, is too brief to be of real value. No references to the literature are given beyond the mention of a few patents and a list of ten books on the subjects treated.

"*Power's*" *Practical Refrigeration.* Compiled by the Editorial Staff of *Power.* Pp. viii + 283. (New York and London: McGraw-Hill Book Co., Ltd., 1921.) 10s. net.

THE practice of ammonia refrigeration, including a simple account of the theory and tables of useful constants, is discussed in this volume. A number of practical hints for users of refrigeration plant, written in a colloquial style, forms about half the book, which should be useful to persons in charge of such plant.

Chemistry of Pulp and Paper Making. By E. Sutermeister. Pp. vii + 479 + 31 plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 36s. net.

THE chemical aspects of paper-making are dealt with in the volume under notice, the mechanical processes being described only in so far as they are necessary for an understanding of the chemistry. Although concerned chiefly with American practice, and less complete than the standard English treatises, the volume should be of service to chemists in paper-works laboratories. It is clearly written and well illustrated.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Directive Tendency of Elongated Bodies.

THIS letter deals with several topics, perhaps somewhat remotely related to one another, but all suggested by previous letters on the same general subject in NATURE of October 20, November 24, December 1, and December 22, 1921.

In my letter of December 22 it was suggested that Mr. Reeves's results might be explained by the peculiarities of the gravity field at the place where the experiments were made. The letter was written before Mr. Reeves's letter appeared and while I was under the impression that his experiments were all made at one place. The suggestion might be plausible as regards any one place, at least until measurements had been made there with an Eötvös balance, but would be highly improbable when applied to every one of the widely scattered places where Mr. Reeves made his tests.

Col. Grove-Hills in his latter in NATURE of November 24 directs attention to an important difference between the turning effect of the earth's field on an elongated body supported at its centre of gravity and the turning effect on a similar body when supported by flotation. He attributes quite undeserved credit to me, however, in stating that this matter is fully treated in my article in the September (1921) issue of the *American Journal of Science.* Only a very special case of the turning effect on a floating body is there treated, and that case is scarcely analogous to the one considered in recent issues of NATURE.

There are two kinds of forces acting on a floating body, namely, the force arising from the earth's gravity field, which is a body force, and the normal pressure of the fluid on the wetted surface. By well-known theorems concerning the transformation of surface integrals into volume integrals it may be proved that the effect of the fluid pressure may be replaced by the body force arising from the earth's field reversed and applied to a solid bounded by the wetted surface and by the free surface of the fluid extended in imagination into the floating body, the density of this solid being the same as that of the fluid. This theorem is proved in very elementary fashion in the ordinary theory, in which gravity is assumed to be constant in intensity and direction, but is equally true when gravity varies in intensity and direction from one part of the region considered to another.

In dealing with the turning effect on a floating body of the earth's field and of the fluid pressure, it is necessary to make some assumption regarding the depth to which the body is submerged; a natural assumption is that the body is submerged to such a depth that the downward pull of the earth's field is just balanced by the upward thrust of the fluid pressure or of the equivalent body force. Let us consider the case of an elongated body symmetrical about a vertical axis through the centre of mass of the body, and let us suppose the earth's field to be also symmetrical about the same axis; there is then no moment tending to turn the body about any horizontal axis. Several terms disappear from the general expression for the earth's field on account of the assumed symmetry, but those remaining represent the component of a force that turns the suspended elongated body about into the prime vertical for a normal field

of force, or in any case into the vertical plane where the curvature of the equipotential surfaces is a minimum. The turning moment of the direct effect of the earth's field about a vertical axis is precisely the same for the floating body as for a like body when suspended. For the total effect of the floating body we must consider also the turning moment of the fluid pressure, or of the equivalent body force, and this, in general, opposes the direct turning effect of the earth's field.

For a body like an elongated right cylinder the two turning effects practically cancel each other, so that the resultant is an infinitesimal of higher order, so to speak, than either turning effect by itself. It is possible, however, by varying the shape of the elongated body to make one or the other tendency prevail. If the body overhangs the fluid considerably, like the bow of a racing yacht, the direct effect of the earth's field has the advantage of position in producing a turning moment, and in the normal case the tendency of the body is to turn into the prime vertical, just as for the suspended body. If the body has its extreme end submerged, thus resembling the mirror images of the ends of the overhanging body, then the contrary tendency will prevail, and in the normal case the body will tend to set itself in the meridian. This tendency to seek the meridian would not, however, be true of all elongated floating bodies of dimensions comparable with those of the Eötvös balance, as Col. Grove-Hills would seem to imply.

My own interest in the effect of the earth's gravity field on floating bodies was due originally to an attempt to account for certain hypothetical displacements of each continental mass as a whole towards the equator. These displacements are believed by a well-known geologist—who for the present, however, does not wish to be quoted by name—to be established almost beyond question. His ideas differ somewhat from those of Prof. Alfred Wegener, of Marburg, who has published much regarding supposed continental displacements. The problem of the equilibrium of the mass of self-attracting gravitating fluid rotating about an axis, with a mass of lighter matter floating in the fluid and projecting out of it, is apparently one of considerable difficulty, especially if we consider the gravitational effects of the floating body on the field of force. Considerations of symmetry would lead us to suppose, however, that the floating body would not be in stable equilibrium at any random point on the surface of the body; the equator of the rotating fluid seems a natural place for stability, and a calculation of the forces acting shows that there is, in fact, a tendency for a floating body to move towards the equator—a tendency stronger, in general, the higher the body floats above the free surface of the fluid.

The difficulty with this equatorward tendency as an explanation of the supposed movements of the continental masses is that the movements appear to have occurred after the earth's crust was well consolidated and there could be no longer any question of floating continental blocks. There is, to be sure, a region of weaker and softer crust around the edge of each continental block, where a sort of syncline dips into the warmer regions nearer the centre of the earth. (All this geology is at second hand, or worse, and should be accepted only with appropriate reservations.) There would be also the weakness underneath the continental mass due to the heat there. In a way this condition resembles that of a floating body, and if for any reason the continental mass should move, the region of weakness around its edges would move with it. However, it does not seem especially probable that the weak gravitational field that tends to move a floating body towards the equator could accomplish very much in moving a continent that forms part of a fairly well consolidated crust.

Even though the equatorward force on a floating body may not be manifest in the displacement of continents, it may perhaps be discernible in the motions of much smaller floating bodies, namely, icebergs. The higher the iceberg the stronger this force. The acceleration may be written approximately for the normal case as

$$\frac{d}{a}\Delta g \sin 2\phi,$$

where d is the distance between the centre of gravity of the floating body and its centre of buoyancy, Δg the difference between the acceleration of gravity at pole and equator, ϕ the latitude, and a the radius of the earth. An iceberg 200 metres in height is rather exceptional for Arctic latitudes, but in Antarctic waters a height of 500 metres (1700 ft.) has been reported (see "The Seaman's Handbook of Meteorology," published by H.M. Stationery Office for the Meteorological Committee, third edition, pp. 132-35). If we suppose the icebergs to be plateaux with wall-sides and to have only one-eighth of their masses above the water, the values of d corresponding to visible heights of 200 and 500 metres would be 100 metres and 250 metres respectively.

The value of Δg is 5·18 cm. and of a $6{\cdot}37 \times 10^8$ cm. The maximum value of the equatorward acceleration on the two icebergs, which occurs in latitude 45°, would be 0·000081 and 0·000203 cm. per sec. per sec. respectively. At latitude 60°, the latitude of Cape Farewell in Greenland, these figures would be reduced to 0·000070 and 0·000176 cm. respectively; but even the smallest of the four accelerations acting for an entire day would, if unresisted, set the iceberg in motion, give it a velocity of more than 6 cm. per sec. at the end of the day, and move it 2·6 km. At the end of twenty days the velocity would be 1·2 metres per sec. and the displacement 1050 km., or more than nine degrees of latitude. With greater acceleration the effects would be greater in proportion.

It is fairly certain, however, that the resistance of the water would prevent the iceberg from actually attaining any of the larger velocities. Probably the terminal velocities from these small forces are of the order of magnitude of a very few centimetres per second. The dominant forces are the winds and currents, but these small forces arising from the earth's field would act more effectively on the higher icebergs and bring them more rapidly into low latitudes. One gets the impression in reading accounts of ice observed in low latitudes that large icebergs are the rule there rather than the exception. There are some obvious reasons for this. The large icebergs are less apt to be overlooked and better able to survive the warm weather than are the small ones. The selective effect of the earth's field is merely an additional reason for the frequent occurrence of large icebergs in low latitudes; to say how important a reason it is would seem to require more data than we now have.

WALTER D. LAMBERT.
U.S. Coast and Geodetic Survey, Washington, D.C., January 20.

Revival of Sporophores of Schizophyllum commune, Fr.

As has been pointed out by Prof. A. H. R. Buller ("Researches on Fungi," 1909, p. 113), sporophores of *Schizophyllum commune* which have curled up as the result of definite xerotropic action can be revived by suitable treatment in a moist chamber. The following illustrations afford interesting photographic confirmation of Prof. Buller's experiments :—

Fig. 1 shows a group of dry sporophores on their original matrix, bark of *Populus sp.*, four months after collection, and Fig. 2 a similar group of the same gathering after revival.

It has been remarked, but not further emphasised by Prof. Buller (*loc. cit.*), that the pileus of *S. commune* is of an absorbent nature. Indeed, the pileus shows a remarkable avidity for water, and the hairs composing the woolly covering of the pileus enable it

FIG. 1.—Xerotropic form of *Schizophyllum commune*. Natural size.

to absorb moisture with a greater rapidity than is usual in fungi, so far as I am aware.

The moist condition of the edge of the pileus remote from the matrix, immediately after wetting the latter, and rendered evident by the transition from snow-white to a silvery-grey colour, led to several experiments. It was found that the application of a drop of water to one edge of a dry pileus resulted in an immediate, and apparently uniform, diffusion of moisture throughout the woolly covering of the whole pileus—about 1·5 cm. diameter. The rate of absorption is much greater than that seen in the absorption

FIG. 2.—*Schizophyllum commune* after revival. Natural size.

of ink by blotting-paper, and this fact was more convincingly demonstrated by the use of a dilute aqueous solution of methylene-blue.

It seems reasonable to suppose that the possession of this property will enable the fungus, in its xerotropic condition, to take the fullest advantage of any raindrop that may fall upon it by instantly absorbing it. This supposition was tested by allowing drops similar in size to tropical raindrops to fall from a height on to the pileus, and it was observed that each drop was immediately absorbed, without splash, until saturation point was reached. Were its absorbent power less, much water would be lost to the fungus on account of its sharply convex outline.

Conservation of water, in the case of a group, is assured by the imbricate habit of *S. commune*. The pileus of a plant growing at the top of a group of sporophores collects all the raindrops that reach it until it becomes saturated, after which the surplus drips on to the pileus of a plant below, and so on, until a whole group has obtained its full requirements without the loss of a single drop.

The moisture-content of the fully expanded fungus and of the xerotropic form respectively are given below. They are the results of one determination only in each case. The specimens were dried in a water-oven at 99°-100° C. for five hours with all the precautions usually taken in the estimation of moisture.

Normal sporophore .	water = 84·3 per cent.
Xerotropic form .	water = 16·0 per cent.

I am indebted to Messrs. Murphy and Son, Ltd., for the use of the accompanying photographs, and to Mr. W. N. Cheesman, of Selby, for the specimens, which were collected at the Worcester foray of the British Mycological Society in September last.

F. A. MASON.

Bureau of Bio-Technology, Leeds.

Statistical Studies of Evolution.

I SHOULD like to suggest that the curves shown by Dr. Willis and Mr. Udny Yule in their article in NATURE of February 9, p. 177, are capable of a different interpretation from that which the authors place upon them.

It is possible that the curves are not, so to speak, a function of the organisms themselves, but rather of their environment.

Consider a habitable area of large size such as a continent. The environment will vary in character in different parts of the continent, the variation being due to the presence or absence of environmental limitations such as warmtn, moisture, particular food, etc.

In the continent considered, the greater the number of environmental limitations in any area the greater will be the number of possible combinations of these limitations. Thus there will be in the continent a great many different kinds of environment with a large number of limitations (such as mountain peaks, deserts, salt marshes, etc.), far fewer kinds of environment with a moderate number of limitations, and still fewer with a small number of limitations.

Since the continent we are considering is large, we can consider it to be divided evenly between areas with many limitations down to areas with few limitations. But we have already seen that there are many kinds of environment possible in areas with many limitations, and therefore each of these areas with one particular environment will be of small size.

Conversely, the areas with fewer possible kinds of environment and few limitations will be large in size.

In fact, could we plot the number of kinds of environment possible in any one size of area against size of area, we should obtain the same type of hollow curve as that obtained by Dr. Willis.

Assuming, as is legitimate, that, on the whole, organisms are adapted to their environments, it follows that areas with many limitations will require many adaptations in the constitution of the organism, and therefore few organisms will live in these areas, and these will be highly adapted types or species.

Hence the small areas with many limitations will each possess a few characteristic species; and since

there are very many such small areas, we see that there will be very many species which occupy small areas.

We can obtain, in fact, Dr. Willis's (number of species) against (size of area) curve simply by assuming (1) that in any very large area the distribution of different kinds of environment is random, and (2) that organisms are adapted to their environment.

I therefore come to conclusions exactly opposite to those of Dr. Willis, for I think we have in his curves direct evidence that:—

(1) Evolution has proceeded almost entirely by natural selection adapting a species to the limitations of its environment.

(2) Animals are so closely adapted to their conditions of existence that it is impossible to conceive of evolution proceeding by the large mutations suggested by Dr. Willis.

Space prevents me considering here Dr. Willis's (number of genera) against (number of species) curves, but these also are susceptible of a similar interpretation in terms of natural selection.

C. F. A. PANTIN.

Christ's College, Cambridge, February 16.

WE find it very difficult to follow the hypotheses made by Mr. Pantin in his interesting letter, and cannot agree that they accord with reality. We cannot see how, for example, the hypothesis that natural selection is the dominant factor affords any explanation of the fact that the numbers and proportions of local species increase towards the south; nor how it can explain the fact that in New Zealand (*cf. Ann. of Bot.*, vol. 32, 1918, p. 339) a great many families show their maximum number of endemics in every genus at the far north, all these families being Indo-Malayan; while a second group of families, characteristic of the northern hemisphere, show their maximum number at the south of New Zealand, and a third group at the centre. The northern families and genera diminish as one goes southward in New Zealand, and pass over, without paying any attention to, the regions where the maxima of the central and southern groups occur. These groups in the same way show no unusual change when they reach the region where the northern maximum occurs. Are the environmental conditions so peculiar at these points that those of the north should cause a multiplication of species only in Indo-Malayan families, and those of the south only in families of the northern hemisphere?

J. C. WILLIS.
G. UDNY YULE.

Columnar Structure in Sandstone Walls of a Glass Furnace.

IN the issue of NATURE for December 29, 1921, p. 567, I described the occurrence of columnar structure in optical glass and in fireclay.

Through the courtesy of Mr. Currie, of the Scottish Central Glass Works, Alloa, I had recently an opportunity of examining columnar structure that had developed in the lowest sandstone course of the side walls of a small tank glass furnace. The walls comprised two upper courses of fireclay blocks, in which no columnar structure developed, and the bottom course of rough-grained sandstone blocks obtained from the Penshaw Quarries, Durham. Their cross-section was about 1 sq. ft. Firebrick jack-arching formed the floor of the tank, under which was situated the regenerator.

The sandstone course was laid in August 1913, and taken down in November 1921, during which operation the structure was observed.

When emptying the tank the floor failed, and the glass discharged itself through a space between the floor and the regenerator roof. Thus while the walls were rapidly chilled the floor was maintained at a comparatively high temperature.

The accompanying photograph (Fig. 1) is of one typical fragment taken from the inner surface; other portions showed curvature of the columns, which at

FIG. 1.

the upper end were nearly normal to the corroded Λ-shaped surface of the joint, and at the lower to the bottom surface of the block.

The similarity between these sandstone specimens and those of optical glass previously illustrated is worthy of remark.

JAMES WEIR FRENCH.

Anniesland, Glasgow, February 13.

The Action of Sunlight: A Case for Inquiry.

READERS of NATURE are no doubt aware that the Medical Research Council has just appointed a Committee on the action of light upon the human body in health and disease, thus meeting the need which I have been allowed to urge in these columns under the above heading (NATURE, December 8, 1921, and January 5).

I see no end to the inquiries in which we are now at last to participate in England, the country the smoke-darkened cities of which need them most. Before me now is a series of papers which I owe to Dr. A. F. Hess, of New York, who has demonstrated that sunlight can cure or prevent rickets in human infants and animals irrespective of the absence or presence of the supposed anti-rachitic vitamin. Again, along this coast, from Cannes to San Remo, I find French and Italian clinicians at work curing what I have called the diseases of darkness by sunlight; also a voluminous literature, as yet entirely unknown in England, which raises questions of high racial, genetic, and eugenic importance, such as the influence of sunlight, or the lack of it, upon the normal development of the reproductive system and its functions during adolescence. But clinicians elsewhere had assured me—and I fear I may have repeated their statements in these columns—that the sun-cure cannot be practised on the Riviera!

Never henceforth, I predict, will the columns of NATURE cease to bear records of the new study of the biology of light now to be begun.

C. W. SALEEBY.

Hôtel Royal Westminster, Menton,
February 19.

The Mechanism of Heredity.[1]

By Prof. T. H. MORGAN, Columbia University, New York City, U.S.A.

II.

Linkage and Crossing-over.

MENDEL'S second law has been found to be restricted in its application. Two pairs of characters do not always assort independently. This fact was first observed by Bateson and Punnett in 1905, and called gametic coupling—not that gametes (ripe germ-cells) are coupled, but that when certain genes enter together from one parent they tend to hold together, as though coupled, in later generations. A specific case will serve to illustrate this kind of inheritance.

If a sweet pea with genes for purple flowers and long pollen grains is crossed to a pea of another strain with red flowers and round pollen, the expectation for the two pairs of genes would be in F_2 9 : 3 : 3 : 1. Instead of this ratio there was found approximately 177 : 15 : 15 : 49. Purple long and red round have come out in the second generation in unexpected ratios, or, in other words, the results are explicable only on the hypothesis that the genes that went in together have shown a tendency to stay together instead of freely assorting.

This coupling is often spoken of to-day as linkage, because it applies not only to two genes, but to any number of them. A few further cases may be given; in one the characters, as in the pea, are not sex-linked, and in the other they are. There is a strain of *Drosophila melanogaster* that is black. It gives with the wild fly in the second generation a 3 : 1 Mendelian ratio. There is another strain that has vestigial wings. It, too, gives with the wild fly a 3 : 1 Mendelian ratio. It is easily possible to make a strain that is pure both for black (*bb*) and for vestigial (*vv*). If a black vestigial male (*bv*) is mated to a wild female (B V) (grey long wings) all of the offspring are grey long (Fig. 11). If one of the F_1 sons is mated to a black vestigial female of pure stock, only two kinds of offspring are obtained; half of them are black vestigial, and half are grey long. In other words, the two recessive characters that went in together (black vestigial) have come out together. These characters are completely linked in the male. It may be said, in exactly the same sense, that the other two characters, the dominant ones, namely, grey long (which went in together from the other side), are also linked. Now if the genes for black and for vestigial are carried in the same chromosome, then their partners or allelomorphs (grey long) lie in the other chromosome of the same pair, and if these chromosomes remain intact the result is what is expected to take place.

Linkage is also excellently illustrated in the case of sex-linked characters. As has been shown, white-eye *versus* red-eye colour of Drosophila gives a Mendelian ratio. Another sex-linked character, yellow colour, also gives the same result. If a strain is made up that has white eyes and yellow colour, and if a female of this strain is mated to a wild-type fly (red eyes, grey colour), all the sons will be white-yellow, and all the daughters red-grey (Fig. 12). If these are inbred, the great majority of the offspring (98·5 per cent) are yellow-white and grey-red (half and half). In other words, these characters are linked, but only in 98·5 per cent. of the cases. The remaining 1·5 per cent. is composed of two kinds of individuals, red-yellow and white-grey. It may be said, therefore, in this case, that the white eye of the yellow type has crossed over to the grey type, and in exchange the red eye of the grey type has crossed over to the yellow type.

The four kinds of offspring obtained in this cross can be accounted for, if once in a hundred times an interchange has taken place between the two X-

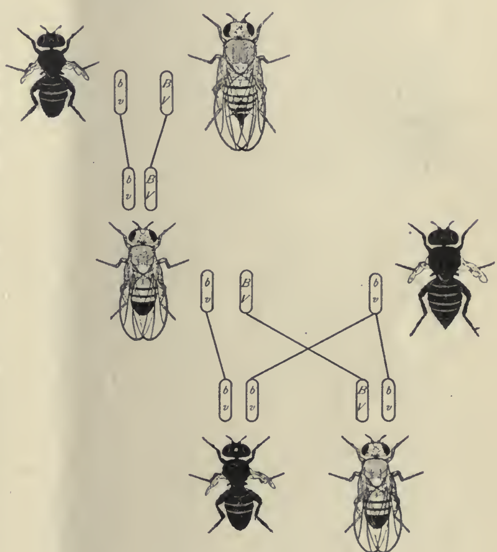

FIG. 11.

chromosomes of the F_1 female, in such a way that the part containing the gene for white eye is interchanged for a corresponding part of the other chromosome with the gene for red eye.

Another example of crossing-over may be given, one involving the same characters, black and vestigial, which were used to illustrate complete linkage. It is possible to use the same combinations of characters to illustrate both absolute linkage and crossing-over, because in the male of Drosophila there is no crossing-over, but in the female crossing-over occurs. Therefore, in the first case above, in which this combination was utilised, an F_1 male was back-crossed, while in the present case an F_1 female will be employed. If, as shown in Fig. 13, a black vestigial fly be crossed to a wild-type fly (long wings, grey), the F_1 female will be wild-type. If she is back-crossed to a black

[1] Continued from p. 244.

vestigial male of pure stock, the F_2 offspring will be of four kinds, in the proportions given below:—

Non cross-overs		Cross-overs	
Black vestigial	Grey long	Black long	Grey vestigial
41·5 per cent.	41·5 per cent.	8·5 per cent.	8·5 per cent.
83 per cent.		17 per cent.	

In this experiment 17 per cent. of crossing-over occurs in the F_1 female. As before, the relation of these facts to the chromosomes is illustrated by the rods in the centre of the diagram. The two pairs of elements (genes) involved are indicated by the letters inside the rods.

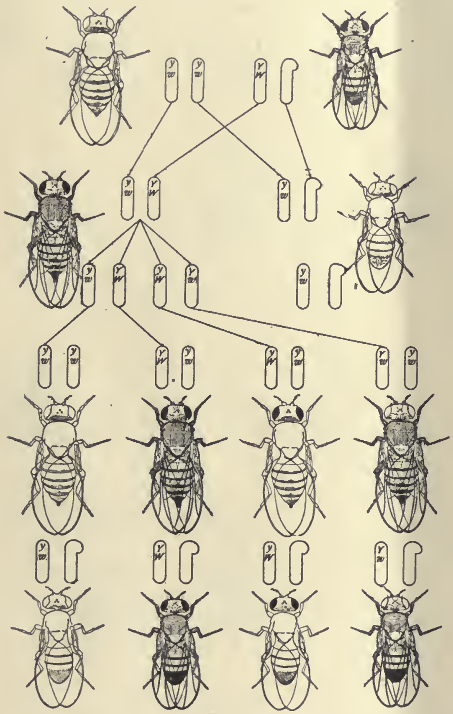

FIG. 12.

Many examples of linkage and crossing-over are known at the present time. Linkage is said to be strong when, as in the yellow-white case, crossing-over takes place in a small proportion of cases. Linkage is said to be weak when crossing-over takes place frequently. Crossing-over may be less than 1 per cent., or even not take place at all (complete linkage), as in the case of the black vestigial male given above. It may take place in nearly 50 per cent. of the individuals of a back-cross, which means that about half of the flies show linkage, and half show crossing-over. This would be, of course, numerically the same result as when the two pairs of characters involved freely assort. A case of this kind could not, in fact, by itself alone be distinguished from a case where the pairs are carried by different chromosomes. It may appear, therefore, incorrect to speak here of linkage, and this would be true were there no other evidence showing that the two characters involved are in the same chromosome. But whenever a number of other characters are known in the same group the linkage of the two characters giving 50 per cent. of crossing-over can still be shown, for if each of the characters is found to be linked to a third one they must be linked to each other.

In Drosophila there are more than one hundred sex-linked characters. If their linkage relations are studied *in series* an important result comes to light. This may be illustrated by the following example. It has been stated that crossing-over takes place in 1·5 per cent. of cases between yellow colour and white eyes. There is another eye character, called echinus,

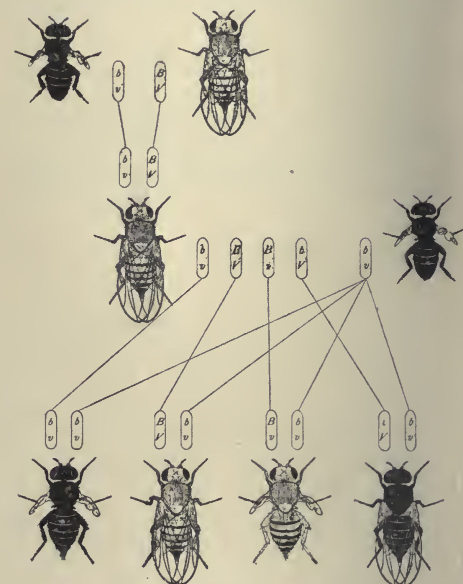

FIG. 13.

that gives 5·5 per cent. of crossing-over with yellow (Fig. 14). If, now, the position of echinus is represented as 5·5 units of distance from yellow, then its "distance" from white must be either $5·5+1·5=7·0$, if it lies to the "north" of yellow, or else $5·5-1·5=4·0$ if it lies to the "south." In fact, when the experiment is made, the percentage of crossing-over between white and echinus is found to be 4·0.

There is another sex-linked character, ruby, that gives 7·5 per cent. crossing-over with yellow. If it lies to the north of yellow it must give with echinus $7·5+5·5=13$; or if to the south of yellow, $7·5-5·5=2·0$. It is found to give 2 per cent. of crossing-over. Hence, lying south of yellow, it should give with white 6·0, and this is what is found.

Such a method of analysis can be followed step by step until the whole of the sex-chromosome is plotted. This procedure has a twofold significance. First, if a new mutant character is found, its "linkage-group" is first made out; then its "distance" from any one

member of that group is determined. It is then necessary to find its position with respect to another known member of the group (preferably one near by) which determines whether it is north or south of the first member. Once this has been done, the method of inheritance of the new character with all other members of its group can be worked out on paper from the crossing-over data, plotted as distance. In other words, the heredity of this new mutant, with all the other known characters of Drosophila, can be predicted, since, with its normal allelomorph, it will give a 3 : 1 ratio; with any character in another group it will give a 9 : 3 : 3 : 1 ratio; and with other members of its own group it will give a definite result which can be calculated from the "distance" of the plotting.

The second point of significance concerning the plotting of the genes in terms of distances is as follows: the discovered relation of genes, as expressed in distances, is one that holds for points in a line. This means that if the genes in question are represented in space, their relation to each other is that of points in a line. If the line is a chromosome, then the chromosomes are to be thought of as made up of a single line of genes. The reasons for referring the genes to the chromosomes have already been given. The possibility of explaining crossing-over on a chromosome basis will be discussed later.

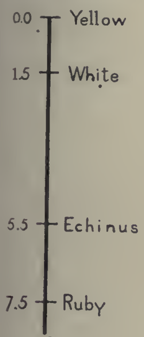

FIG. 14.

There is one situation where, on superficial examination of the data, an apparent disturbance of the linear order may appear, namely, when crossing-over takes place at two levels in the same linked series at the same time (double crossing-over). But by marking intermediate points between the extreme ones all double cross-overs can be detected and the distances corrected for them. When this is done, it at once becomes apparent that the linear order is the correct arrangement of the genes. In fact, far from throwing doubt on the linear order, these cases, where double crossing-over occurs, furnish a strong corroboration of the correctness of the hypothesis.

The use of the word "distance" as an expression for the percentage difference in crossing-over values does, unfortunately, lend itself to misunderstanding, unless one knows just what meaning is attached to the word when used as defined above. An example will make this clear. If crossing-over is more likely to occur in one region of the linear order than in other regions, the plotted "distances" will be relatively too short in comparison with the distances of the remainder of the series. Distance, therefore, must be understood in a relative, not in an absolute, sense. We have been aware of the necessity of this restriction from the beginning of our studies of the linear order of the genes, and have warned others of the danger in numerous publications, but apparently without complete success. It has also been shown that the percentage of crossing-over changes under external (Plough) and internal (Bridges) conditions. As the female gets older, crossing-over becomes less in some cases, hence the "distances" appear to become less. It has also been shown by Sturtevant that genetic factors may exist that affect the crossing-over in certain regions of the linear series, in one case shortening that region to zero, since all crossing-over is suppressed. But the significance of this result, from our present point of view, is that when the shortening factor is removed (by a definite genetic procedure) the original distance of the genes in this region reappears, *and the genes are shown not to have changed their original order.* This reassures us that the linear order stands on a firm basis. A recent attack on the theory of the linear

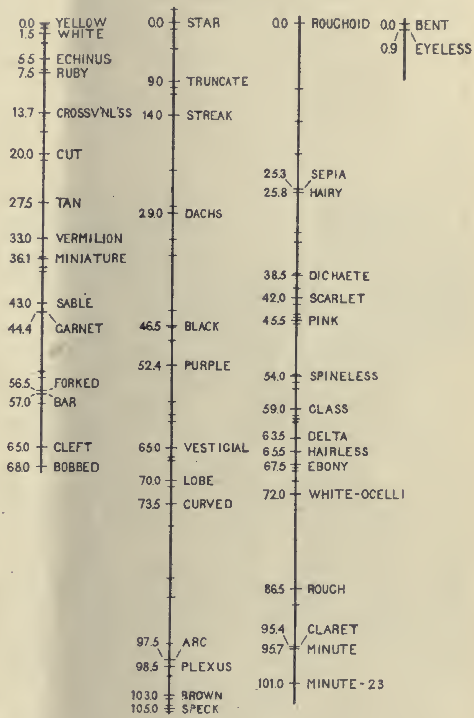

FIG. 15.

order is based on evidence that shows that "through selection" the distances between certain genes changed. The result really has no bearing on the point, because the order of the genes was not shown to have been affected. Moreover, Sturtevant's case, more thoroughly worked out, shows that where even greater changes of distance had taken place the order of the genes had not changed.

The plotting of the linear order of the genes in the four chromosomes of *Drosophila melanogaster* is shown in Fig. 15. The four great groups of linked genes are represented by straight lines with the approximate positions of the genes indicated by short cross-lines. The numbers opposite these cross-lines give the distances from a base chosen as far "north" as possible. The location of some of the genes rests on an immense

amount of data; other genes are less accurately placed. Still others, not so well determined, have been omitted from this diagram.

The localisation of the genes has been calculated from numerical data independently of any assumption as to how crossing-over takes place in the animal. Perhaps it might be safer to let the matter rest on the genetic evidence alone in the present uncertain frame of mind of most cytologists concerning the conjugation of the chromosomes at maturation; but there are at least certain facts admitted by a number of cytologists concerning the maturation of eggs and sperm that seem to fall into line with the simple mechanism that the genetic evidence for crossing-over calls for. This evidence may next be considered.

(*To be continued.*)

Science in Poland.

DURING the past seven years Poland has suffered all the miseries of war. Amid the desolation in which the country was plunged, the votaries of science did their best, until 1919, to uphold the interests of study and education against inimical and contending Governments; since the Polish State was resuscitated they have been engaged in laying the foundation of the work of the future. In 1914 only two Polish universities (Cracow, Lwów) were in existence; in 1922 five large State-endowed universities are actively

FIG. 1.—Interior Court of the Library of the Jagellonian University, Cracow, with the statue of Copernicus.

at work; the University of Warsaw was started in 1915, those of Poznan and Wilno in 1919. Centres of technical teaching and research are springing up; in Warsaw and Lwów important colleges of mechanical and electrical engineering, of applied chemistry, of architecture, etc., are well attended, and in 1919 a High School of Mines was established in Cracow. These institutions are sufficiently equipped with appliances required for practical teaching.

Agricultural science also receives a good deal of attention; in addition to faculties or other schools of university rank existing in Cracow, Warsaw, Lwów, and Poznan, a National Institute of Agricultural Research was founded in Pulawy in 1917. This institute is under the direction of Profs. Godlewski and Marchlewski, and shows a remarkable completeness of arrangement. For the study of the mineral resources of Poland, a National Geological Institute was created in 1920 in Warsaw, under Prof. Morozewicz; a branch institution in Cracow, under Dr. Nowak, has for its object the investigation of oil-bearing regions. An Epidemiological Institute, a Central Meteorological Office, and a Natural History Museum have been constituted; but within the brief compass of an article it is impossible to do more than refer simply to the fact of their inauguration.

At the head of Polish educational institutions stands the Jagellonian University of Cracow, founded by Casimir the Great, King of Poland, in 1364. In 1400 the university was restored and enlarged by King Ladislas Jagello, who thus complied with the last wish of his universally honoured and beloved wife, Queen Jadwiga. At the end of the fifteenth century the university was at the height of its influence and fame; there was probably no contemporary school in Europe where mathematics and astronomy were prosecuted with more zeal and success. An undergraduate matriculated in the university in 1491 who was to transmit his name to the remotest posterity. At that time Wojciech Brudzewski (Albertus de Brudzewo) had attained a wide and established reputation as an astronomer, and it was probably by him that young Copernicus was taught to employ his genius.

In the seventeenth and eighteenth centuries the university suffered much from the insecurity of the times, and for many years was on the decline. A new epoch began about 1870; an impulse was given to study, and research, although hampered by financial embarrassments, had greater importance assigned to it than at any previous period. Among the mathematicians of that period are Mertens, Baraniecki, and Zrawski; Rudzki did creditable work in geophysics, especially seismology; Zygmunt Wróblewski and Karol Olszewski, by their activity in the domain of low temperature research, achieved success that shed lustre on the Cracow laboratories; Witkowski, by the pains he took to ensure accuracy, paved the way for much subsequent thermodynamical investigation; Smoluchowski (whose untimely death, in 1917, was a matter of universal regret) accomplished brilliant work, largely influencing progress towards a kinetic theory of matter. Within the precincts of the Jagellonian University, Janczewski, E. Godlewski, Sen., Rostafinski, Raciborski, Rothert, Kulczynski, Prazmowski, Wierzejski, Jentys, Adametz, Majer, Kopernicki, and Talke-Hryncewicz — names well known to students of

botanical, zoological, or anthropological science—were engaged in teaching and research. The medical faculty will always be associated with the names of Dietl, Teichmann, Cybulski, Browicz, Jordan, Pieniazek, Korczvnski, Jaworski, Mikulicz, Rvdygier, Wicherkiewicz, and others.

The Jagellonian University always consisted, and now consists, of four faculties. The faculty of theology has nine professors; the faculty of jurisprudence has sixteen professors and four lecturers; while the faculty of medicine includes twenty-six professorial chairs and thirteen lectureships. The philosophical faculty embraces literature and philology, history and philosophy, mathematical, physical, and natural science; in connection with this faculty there is a college of agriculture, a department of pharmacy, and a teachers' training school. No less than sixty-eight professors and twenty-two lecturers are engaged in the work of this faculty. The total number of matriculated students during the session 1921–22 is 4631.

Space will permit only of a reference to the library of the university (Biblioteka Jagiellonska), renowned for the precious MSS. it contains.

L. N.

Current Topics and Events.

THE national manifestation of rejoicing on the occasion of the marriage of H.R.H. Princess Mary to Viscount Lascelles on Tuesday, February 28, is a sign of the secure place which the Royal Family occupies in the hearts of the British people and also, we hope and believe, a token of national unity. In common with all classes of the community, workers in scientific fields marked the occasion with affectionate interest and shared with much satisfaction in the chorus of good wishes by which the nation expressed itself in perfect harmony with a happy event.

THE following fifteen candidates have been selected by the Council of the Royal Society to be recommended for election into the Society:—Prof. T. H. Bryce, Mr. C. G. Darwin, Dr. C. G. Douglas, Dr. S. R. Douglas, Prof. A. J. Ewart, Dr. A. Hutchinson, Dr. F. W. Lanchester, Mr. J. Mercer, Prof. S. R. Milner, Prof. M. S. Pembrey, Prof. F. Lee Pyman, Prof. G. A. Schott, Dr. N. V. Sidgwick, Mr. D. M. S. Watson, Sir Alfred Yarrow, Bart.

THE Report of the Aeronautical Research Committee on the causes which led to the loss of the airship R. 38 was issued by the Air Ministry on February 23. The Committee has come to a number of clear findings and has summarised them at the end of its report; it has concluded, from an examination of the evidence available, that the airship broke in two as a result of defects in design, but that the loss of life was to be attributed largely to a subsequent fire. It appears that the only calculations made by the designers were of the type used in general engineering and had little special reference to airships. In addition, no account was taken of the aerodynamic forces which an airship might reasonably experience in normal usage. Information as to the importance of the air forces is said to have existed from experiments on models of airships in the wind tunnels, but the warning was not acted upon even to the extent of referring the problem to the Aeronautical Research Committee. Shortly expressed, the result of the enquiry shows the marked deficiency of rule-of-thumb as compared with scientific methods as an instrument of progress. The accounts of the accident in America to the semi-rigid airship, *Roma*, further point the moral. The obvious fundamental fact in engineering design is that the details of a structure should depend on the forces it has to withstand. In an airship the bending arises in part from the distributed weights and in part on aerodynamic loading, the former being independent of the speed of flight and the latter to its square. Hence an airship moving at 30 knots may have the stresses due to weight and buoyancy twice those due to aerodynamic causes, whilst at a speed of 60 knots the proportions are exactly reversed. The accident to R. 38 appears to have occurred when the air loading was at least five times that provided for by the designers on the basis of weight alone. There is great difficulty in introducing improvements into aircraft with the present official organisation, and it is to be hoped that the report will receive due consideration from the point of view that it is desirable to provide for scientific progress rather than for a process of trial and error on a large scale and at great expense in life and money.

THE third and final Report of the Committee on National Expenditure (Cmd. 1589, price 4*s*.), issued on February 24, deals, among other services, with the British Museum, National Gallery, National Portrait Gallery, Wallace Collection, London Museum, Imperial War Museum, Geological Museum, and National Galleries (Scotland). The Estimates for 1921–22 and the Provisional Estimates for 1922–23 are respectively £506,771 and £405,864. Over 80 per cent. of the Estimate is in respect of the cost of personnel. The Committee thinks that further economies might be produced by a close investigation into the size of the warding staff, especially in the case of the British Museum and the Natural History Museum. It recommends that there should be four paying days a week for all National Museums and Art Galleries without distinction. The Committee is of opinion that the net sum of £405,864, which is asked for in the Provisional Estimates for 1922–23, should be reduced to £392,264, a saving of £13,600. With regard to the grants for scientific investigation, amounting in all to £200,423, it is recommended that the grant to the Medical Research Council—£130,000—should be as proposed by the Treasury. As regards the smaller grants, the Committee says: " We are averse from an arbitrary and uniform reduction on a percentage basis on the ground that the saving to the Exchequer would be small compared with the detriment which would be caused to the activities of the learned and scientific world and the discouragement which would be given to private subscriptions and donations if the Exchequer grants were reduced. We therefore recom-

mend that the Provisional Estimate, as framed by the Treasury, should be accepted, with the qualification that it may be possible, under the terms of the Irish Settlement, to omit £2200 proposed for the four Academies and Societies in Ireland. The Department of Scientific and Industrial Research was instructed, in May last, to effect at least a 20 per cent. reduction on expenditure. The Department succeeded in effecting this, and presented a Provisional Net Estimate of £330,287. Since arriving at that figure the Department and the Treasury have agreed on an additional cut of £17,700, and, as the result of a further review, the Department have intimated that a still further reduction can be made, which will bring their Net Estimate down to £298,071. We are unable to recommend any further reduction beyond the saving of £32,216 already effected."

THE Minister of Health announced last week that the Rockefeller Foundation had offered a sum of two million dollars (approximately £454,000 at the present rate of exchange) for the provision of an institute of State Medicine in London—site, building and equipment—on the understanding that the British Government accepted the responsibility for staffing and maintenance. At present public health teaching is given at some seven or eight institutions in London, which instruct about 120 students per annum for the examinations for the Diploma of Public Health; for toxicology and medical jurisprudence practically no advanced course is available. The need for an Institute of State Medicine has long been recognised, and some years before the war the Board of Hygiene of the University of London formulated a scheme for the provision of such an institute, but funds for its establishment were never forthcoming, and in 1921 the Committee for post-graduate medical education in London made a similar recommendation. The offer of the Rockefeller Trustees has been gratefully accepted by the Minister of Health, and the Government proposes, we believe, to allocate a sum of £25,000 annually for the maintenance of the Institute, the work of which will be devoted both to education and to research in all branches of State Medicine.

ON Wednesday, March 1, there was opened at the British Museum a special exhibition of Greek and Latin papyri presented at various dates by the Egypt Exploration Society. This body (formerly the Egypt Exploration Fund) is celebrating the twenty-fifth anniversary of the foundation of its Graeco-Roman Branch, the excavations of which at Behnesa (Oxyrhynchus) and elsewhere have made so many additions to our stock of Greek literature and to our knowledge of the political, economic, and social history of Graeco-Roman Egypt; and it is in honour of the anniversary that the Museum is arranging its exhibition. A guide-book to the exhibition, with introduction, detailed descriptions of the papyri shown, a preface by Sir Frederic Kenyon, and one photographic facsimile, is being published by the Society, and will be on sale at the Museum, price 1s. The exhibition, which will be found in the MSS. Saloon, Case A, includes many interesting papyri of various kinds, selected to illustrate the wide range of papyrological discovery. There are examples of famous additions to Greek literature, like the Paeans of Pindar, the poems of Cercidas, and the Oxyrhynchus historian; theology is represented by the Sayings of Jesus; and the economic and social life of Egypt finds illustration in many non-literary documents, several of them rich in human interest.

THE Referee, under section 1 (5) of the Safeguarding of Industries Act, has given judgment against the complaint of the British Cellulose and Chemical Manufacturing Company, Limited, that calcium carbide had been improperly excluded by the Board of Trade from the lists published by them of articles chargeable with duty under Part I. of the Act. The effect of the award is that calcium carbide is not to be subject to import duty.

THE ambitious project for opening up a navigable channel of sufficient width and depth to enable ocean-going vessels to reach the group of inland ports fringing the shores of the Great Lakes of North America, and there to ship and discharge their cargoes direct without any intermediate handling, is steadily being urged in influential quarters, and, despite strong and determined opposition, appears to be gaining ground. The report of the International Commission, which has been holding an inquiry into the feasibility, necessity, and cost of the scheme, has just been presented to the respective Governments at Washington and Ottawa. The position may be briefly summarised as follows:—At the present time vessels loaded with grain at the great depôts of Port Arthur, Fort William, Duluth, and Superior, on Lake Superior, and of Chicago and Milwaukee, on Lake Michigan, are unable, on account of the rapids on the St. Lawrence, to proceed further than Buffalo, at the lower end of Lake Erie, where the grain has to be transferred either into barges to proceed along the Erie Canal to New York for reshipment or into small ships capable of traversing the Welland Canal as far as Montreal, where again reshipment is required for the ocean journey. This repeated handling of the cargoes means increased cost of carriage, delay, and dearer bread for the countries to which the grain is consigned. The necessity for transhipment can be avoided only by the formation of a waterway of sufficient capacity for ocean-going vessels, and, as contemplated in the proposed scheme, this means the enlargement and deepening of the Welland Canal from a depth of 25 ft., to which it is at present being increased, to a depth of 30 ft., and the construction of four lateral canals and impounding dams at the rapids on the St. Lawrence River, together with the deepening of the river-bed itself. There is an additional advantage attaching to the scheme in that by the construction of the dams a very considerable amount of hydro-electric power could be developed, and it is claimed that on this ground alone the project should prove a sound and profitable enterprise.

WE learn from *Science* that Capt. Roald Amundsen has made arrangements for co-operative work in

terrestrial magnetism and atmospheric electricity with the Department of Terrestrial Magnetism of the Carnegie Institution of Washington throughout his forthcoming expedition to the Arctic regions. During the North-East Passage, 1918–21, the Amundsen Expedition made a series of highly valuable magnetic observations at rather more than fifty different points, and Capt. Amundsen's chief scientific assistant, Dr. H. U. Sverdrup, has been associated with the Department of Terrestrial Magnetism since last October in order to complete the reduction and publication of the magnetic observations thus far obtained by the expedition. He will rejoin the *Maud*, Capt. Amundsen's vessel, early in March at Seattle. It is expected that Capt. Amundsen will resume his Arctic expedition, the chief object of which is to obtain scientific data relating to geography, oceanography, meteorology, gravity, terrestrial magnetism, and atmospheric electricity, about June 1.

H.R.H. The Duke of York will open the Research Laboratories of the British Cotton Industries Research Association, Shirley Institute, Didsbury, Manchester, on Tuesday, March 28. The opening ceremony will take place at 3.30 P.M.

THE Société Genevoise d'Instruments de Physique informs us that it has not at the London address, 95 Queen Victoria Street, E.C.4, a specimen of the printing chronograph referred to in Our Astronomical Column on February 16, p. 217.

THE trustees of the Percy Sladen Memorial Fund have given a substantial grant towards the expenses of the expedition to S.W. China by Prof. J. W. and Mr. C. J. Gregory, who are leaving for Rangoon at the end of March. The expedition will therefore be conducted as one of the Sladen Trust Expeditions.

PROFESSOR NILS BOHR, of the University of Copenhagen, will give a course of five lectures on the "Quantum Theory of Radiation and the Structure of the Atom" in the Cavendish Laboratory, Cambridge, on March 6, 7, 10, 13, and 14, at 4·45 P.M. The last two lectures, of a more advanced character, will deal with "Selected Problems in the Theory of Atomic Constitution."

THE members of the Geologists' Association of London are about to entertain at dinner their retiring President, Mr. William Whitaker, F.R.S. Mr. Whitaker, who is in his 86th year, joined the Geological Survey in 1857 and the Geologists' Association in 1875. He has frequently served as a member of the Council and has conducted innumerable excursions. He was President from 1900 to 1902, and has recently completed a second term of office. The dinner will be held on Saturday, March 25, at Stewart's Restaurant, 50 Old Bond Street, W., at 7 o'clock. A large attendance is expected.

AT a joint meeting of the Faraday Society and the Oil and Colour Chemists' Association, to be held on Thursday, March 9, at 8 P.M., in the rooms of the Chemical Society, Burlington House, W.1, a group of papers will be presented dealing with the properties of powders considered from various aspects. Prof. T. Martin Lowry and Mr. L. C. McHatton will deal with the grading of powders by elutriation, Prof. P. G. H. Boswell will contribute a paper on elutriation from the point of view of the geologist, and Dr. J. W. French will speak on grinding and polishing powders. Dr. R. S. Morrell, Mr. C. A. Klein, and Mr. W. J. Palmer will discuss the subject from the point of view of the oil and colour chemist, and Mr. R. W. Whymper will deal with certain applications to cocoa and chocolate. The subject will then be thrown open for general discussion.

Our Astronomical Column.

RELATION OF SPECTRAL TYPE TO MAGNITUDE.—The Henry Draper Catalogue of the Spectra of Stars, which is now completed but not yet fully published, contains as many as 225,000 stars. The classification is based on the Harvard system, wherein more than 99 per cent. of all the stars fall into the six main groups designated by the arbitrary letters B, A, F, G, K, and M. It is now known, from the work of Lockyer and Russell, that the actual sequences of changes in a star's spectrum are from M to B as the star increases in temperature (giants), and from B to M as the star cools (dwarfs). Thus for each letter mentioned above there are two distinct kinds of stars, and the nearer the letter is to M the greater this distinction becomes. It is necessary, therefore, to bear this fact in mind when reading the Harvard College Observatory Circular (No. 226) on the relation of spectral type to magnitude by Dr. Harlow Shapley and Miss Annie J. Cannon. Of the numerous tables given in the paper the following abstract of one of them exhibits some of the main results of the investigation.

The second column may be considered as representing the distribution of naked-eye stars among the various spectral classes. It will here be seen that the hot A stars exceed in number those of any other type, the cooler K class running it a close second. This state of things is reversed in the three following columns, which show a drop in magnitude for each

Spectral division	Visual magnitudes brighter than			
	6·25	7·25	8·25	9·25
B	719	1,286	2,061	3,026
A	2,018	5,904	15,884	39,342
F	680	2,160	6,536	15,224
G	656	2,456	8,776	27,160
K	1,984	6,144	20,760	51,008
M	538	1,453	4,491	10,657

column. In all columns, however, the A and K type stars are prominent features. In discussing the frequency of spectral divisions for successive fainter magnitude intervals, the B type stars rapidly fall off as fainter stars are considered. The A stars fall off to about the 8th magnitude, but then rapidly rise again. The F and M types maintain their frequency nearly throughout to magnitude 8·5, but fall slightly afterwards. The frequency of the G type increases very rapidly throughout the whole series up to magnitude 9·5, while the K class increases up to the 8th magnitude and then falls off. A plate accompanying the paper shows graphically many of the features of the tables.

Research Items.

MAYA HIEROGLYPHS.—Though much attention has been bestowed on the decipherment of the Maya hieroglyphs since a key was supplied by Diego de Landa, the first Spanish bishop, the result, except as regards some numerals, has been disappointing. It is obvious that the way to begin such a study is by an examination of the modern language of the country, as the study of Coptic has helped in ancient Egyptian. Hitherto the grammars of the Maya tongue have supplied an inadequate basis for its study, because their authors, Spanish priests, were ignorant of philology and phonetics and tried to build up a grammar of a primitive language by following the Latin or Spanish models. This naturally led to two classes of defects: unnatural forms were invented to express corresponding ideas in Latin or Spanish, and numbers of native expressions were overlooked because they could not be brought within the European system. Mr. A. M. Tozzer, the first travelling fellow in American ethnology of the Archæological Institute of America, spent a considerable time in Central America, from 1901 to 1905, and he issued in 1907 a report of his ethnological work. This he has now followed up by a comprehensive grammar of the Maya language on modern lines and a bibliography of the literature. He omits any discussion of the phonetic character of the Maya hieroglyphs, and he deals with the language as unrecorded up to the time of the Spanish conquest. But he justly remarks that any elucidation of the hieroglyphs will be impossible until an advance is made in our acquaintance with their phonetic elements. This in recent years has not advanced in comparison with the gains made in deciphering the numerical parts of the hieroglyphic writing. A successful correlation of the modern Maya language with the hieroglyphs holds out a prospect of success. In this respect Mr Tozzer's book, forming vol. 9 of the Papers of the Peabody Museum of Archæology and Ethnology, Harvard University, deserves hearty commendation.

MARINE MOLLUSCAN FAUNA OF AMERICA.—A useful summary of the marine shell-bearing molluscs of the north-west coast of America has been published by Mr. W. H. Dall (U.S. Nat. Mus. Bull. 112, pp. 217, 22 plates). In the preparation of this summary the results of more than fifty years' study of the molluscan fauna of the north-west coast have been brought together, Mr. Dall's investigations having begun in 1865. The molluscan fauna of this coast falls into three main divisions—the Arctic, containing many circumboreal species, and extending from the Arctic Sea to the southern limit of drift-ice in winter in the Bering Sea; the temperate, extending from this line southwards to Point Conception, California; and the tropical, from the latter place to Point Aguja on the coast of Peru. The total number of species (excluding nudibranchs and cephalopods) for the region is 2122. The Tertiary and Pleistocene fossils of the shores of Bering Sea afford evidence of a communication with Atlantic waters during the prevalence of more genial conditions. Several species now living in Bering Sea are found fossil in the late Pliocene of Nantucket and the Pliocene of Iceland, and, conversely, the common periwinkle of New England (*Littorina palliata*) is one of the species found in the elevated beaches of Nome, Alaska, and is now extinct on the Pacific coast. The intercommunication between the two oceans would seem to have been tolerably free at the time, though now there are quite pronounced differences between the Greenlandic and the Bering Strait Arctic assemblages of molluscs.

A PARASITIC AMŒBA WITH PATHOGENIC CAPACITIES.—Prof. C. A. Kofoid and Dr. Olive Swezy have recently described (Univ. California Zool. Publ., vol. 20, No. 7), under the name *Councilmania Lafleuri*, a parasitic amœba of the human intestine which "appears to have pathogenic capacities." They state that this organism is apparently cosmopolitan in distribution, but has hitherto been confused with *Entamoeba coli* because of its eight-nucleated cyst. The cyst has a thick wall, and in addition to the eight nuclei, each with a large dispersed karyosome, there are in the protoplasm acicular chromatoid bodies, fasciculate or massed in the later phases. The cysts are spheroidal, ellipsoidal, or asymmetrical, and their non-spherical form and the dispersed karyosome are among the characters given to distinguish this new amœba from *E. coli*. In fresh stools the cysts exhibit a process of repeated budding, resulting in the escape of amœbulæ. Protoplasm issues through a minute pore formed in the cyst-wall, a nucleus slips out into the protoplasmic bud, and this bud detaches itself as an amœbula. A new bud is formed and creeps away, and so on until as many amœbulæ have been produced as there were nuclei. The authors are emphatic that this is a normal process. They state that in the division of the nucleus in the cyst eight chromosomes are demonstrable at the metaphase, whereas *E. coli* has only six. In ordinary practice there will be great difficulty in distinguishing the active stages of Councilmania from those of *Entamoeba histolytica* and the cysts from those of *E. coli*. The reason for creating the new genus Councilmania is not obvious, and is not stated by the authors.

BUD MUTATIONS.—That bud sports, or bud mutations, frequently give rise to important new varieties has long been known. Darwin studied many such cases, and Cramer in 1907 compiled an account of all the cases then known. Mr. A. D. Shamel, in a recent publication of the Experiment Station of the Hawaian Sugar Planters' Association, describes and clearly illustrates many modern instances. He believes that in many plants the selection of bud mutations is quite as important as seed selection in the origination of new varieties. Such occurrences are notoriously frequent among citrus fruits, where many often occur on the same tree, but they are also relatively common and have given rise to new varieties in potatoes, sugar-cane, apples, peaches, and pears, as well as in grapes, plums, strawberries, and a great variety of cultivated garden-plants, such as dahlias, chrysanthemums, roses, and carnations. Less is known concerning the frequency with which they will come true from seed, and this, of course, lessens their evolutionary significance.

PRESERVATION OF THE KAURI PINE.—Most of the Kauri pine, *Agathis australis*, the finest conifer south of the equator, has been destroyed in New Zealand by the lumberman. It is satisfactory to learn from the State Forest Report for 1920–21 that a remnant of the primeval forest of this species near Dargaville, 908 acres in area, was acquired by the State last year, and will be preserved intact as the National Kauri Park. An illustration in the report shows the stem of one veteran which is 36 ft. in girth. Other forests, of which the Kauri is an important constituent, need not, however, disappear. Investigations commenced a year ago by Mr. W. R. McGregor show that this species is readily regenerated under the shade of a natural-shelter wood. Complete re-establishment of a felled area requires a period of

twenty-five to fifty years, and is effected by the selection method. With proper precautions against fire, the Kauri forests that remain in New Zealand can be so managed as to yield a rich store of timber for centuries to come. The other important conifers in New Zealand, *Dacrydium cupressinum*, *D. Colensoi*, *Podocarpus dacrydioides*, and *P. totara*, also regenerate vigorously, and the process of their regrowth is in evidence in all situations where fire and grazing are excluded.

THE MOSS ROSE.—The origin of the moss rose is the subject of a paper by Major Hurst and Miss M. S. G. Breeze in the current issue of the Journal of the Royal Horticultural Society. It differs from the cabbage rose (*R. centifolia*) only in the much greater development and branching character of the glands on petioles and sepals and the branching of the latter. The cabbage rose has been in cultivation for more than two thousand years, and the earliest record of the moss rose is from Carcassonne, in southern France, where it probably originated as a bud-mutation from the cabbage rose at least as early as 1696. The mossy character has since arisen independently from two other varieties of the cabbage rose. In 1775 the Unique Rose appeared in a garden in the Eastern Counties as a tinged-white variety, and in turn gave rise to the "Unique Moss" through a bud-mutation in France about 1843. The Rose de Meaux is a miniature variety of the cabbage rose which may date from about 1637. A moss mutation appeared from this in the West of England in 1801. Both the moss and cabbage rose are sterile, and there is little doubt that all these derivatives arose from the old cabbage rose as bud-mutations. The records show that at least seven bud-reversions from the moss rose to the cabbage rose occurred in the period between 1805 and 1873. In the half-century following 1788 seventeen varieties of the moss rose appeared, one of which was single and fertile and extensively used in crossing. Twelve of these bud-mutations are parallel to corresponding earlier variations in the old cabbage rose. Bud-mutation is therefore a frequent phenomenon in *Rosa centifolia* under cultivation, and there is, as the authors suggest, a direct connection between this condition and the sterility. The evidence indicates that the mossy character is probably a simple Mendelian dominant.

THE EXAMINATION OF TEXTILES BY X-RAYS.—An interesting addition to the many and varied uses of X-rays in the examination of materials has been developed by Messrs. Truesdale and Hayes in the research laboratory of the Dunlop Rubber Co., Birmingham. In the Journal of the Textile Institute, vol. 12, No. 11, November 1921, they describe how, by the aid of radiography, they have studied the movement of the threads in the canvas of a motor-tyre during the several processes of manufacture of the tyre. For this purpose the canvas was specially woven so that every twentieth thread, both warp and weft, had been previously impregnated with a heavy salt. Thus the X-ray photograph reveals a series of squares, the pattern being in the form of a check. The most suitable salt for the purpose was found to be lead chromate formed by precipitation on the yarn by first soaking it in lead acetate and then in potassium bichromate. The X-ray plates or films were placed in actual contact with the material, so that the dimensions of the radiograph were those of the canvas. In the case of a tyre the film was placed inside the tyre, in contact with the first ply, and held in position by spring clips. The X-ray tube was on the outside, and care was taken that the X-rays were normal to the film. As the series of reproduced radiographs shows, the dimensions of the sides and angles of the squares are affected in some of the processes. By measuring predetermined squares on the radiograph taken after each process the change due to the previous process can be arrived at. The method proves to be an effective means of ascertaining whether the stretch of the canvas threads, resulting from the various processes in the manufacture of the tyre, is within the limits of stretch tolerated by the yarn—a point of extreme importance to the tyre manufacturer.

PROPAGATION OF EARTHQUAKE WAVES.—Dr. S. W. Visser, of the Royal Magnetic and Meteorological Observatory of Batavia, has recently issued an important paper on "The Distribution of Earthquakes in the Netherlands East Indian Archipelago during 1910–19, with a Discussion of Time-tables." For several years the tables in use of the times of transit of the primary and secondary waves as recorded on seismometers have been recognised as requiring corrections, and both Geiger and Gutenberg in Germany and G. W. Walker in this country have made definite suggestions towards this end. By a detailed discussion of the earthquakes having their origin near Batavia, Visser has been able, by means of a careful examination of the records obtained at distant stations, to draw up new sets of tables so far corroborating the suggestions already made, but carrying out the corrections much more completely and through the whole range of distances from the epicentre. The corrections of the primary times of transit are most conspicuous in the range from 50° to 100° arcual distance, being an increase of as much as 10 seconds at the distance of 60° or 70°. In the case of the secondary times of transit the corrections are more in evidence, being a decrease for small arcs (less than 50°), an increase for larger arcs (up to 70°), and a marked decrease for arcs greater than 80°. Visser also discusses what seems to be the manner of propagation of the waves which enter the nucleus of the earth, and gives general support to the views expressed by Knott in his recent paper on the propagation of earthquake waves. In the light of the corrections now supplied it will be necessary to recalculate the forms of the seismic rays, especially for the secondary waves. Visser fully bears out the conclusion already come to that the primary wave ceases to be recorded at distances greater than about 110°, but finds evidence of their reappearance beyond 140° with a retarded time of transit.

HARMONIC DEVELOPMENT OF TIDAL THEORY.—Dr. A. T. Doodson, of the Tidal Institute, University of Liverpool, has just published in the Proceedings of the Royal Society (A, vol. 100, p. 305, 1921) a paper on "The Harmonic Development of the Tide-generating Potential." Since 1883 the development given by Sir G. H. Darwin has been universally used and has proved of remarkable value, but the assumption usually tacitly made, that no terms not included in his schedule need be considered in tidal prediction, has been shown by work at Liverpool on tidal observations to be unjustified. It was therefore decided to make a new development in which, in view of the possibility of terms being magnified by resonance, great accuracy has been striven after. All terms the coefficients of which exceed one ten-thousandth of the leading term are included; this degree of accuracy is unnecessary for practical tidal work, but the needs of research were also kept in mind. Unlike Darwin's development, which was algebraic and founded on the old lunar theory, referring everything to the orbit rather than to the ecliptic, the present work is essentially numerical and strictly harmonic; Brown's new lunar theory is taken as the basis of the development. Many terms which are too large to be ignored for modern purposes, but do not occur in Darwin's schedule, have been found.

The Jubilee of the Institution of Electrical Engineers.

IT is now fifty years since the Society of Telegraph Engineers held its first meeting. The title of the Society was changed to that of the Institution of Electrical Engineers in 1883, and it has grown from a membership of about 100 in 1872 to one of more than 10,000 in 1922. Last year the Institution was granted a Royal Charter, and it celebrated its jubilee last week by holding meetings at which some of the pioneers of electricity gave recollections of the early days of the industry.

Prof. Fleming gave fascinating lectures on Michael Faraday. He showed how well this great investigator laid the foundations on which the impressive superstructure of modern electrical practice has been built. In particular he laid stress on the marvellous thoroughness with which Faraday stated the physical laws of electrolysis and electromagnetism. Many of Faraday's statements which survive intact in our modern text-books are models of lucidity. For its rapid development the industry is largely indebted to the unselfish labours of this great physicist.

Electrical engineering more than any other branch of engineering is based on pure science. The ease with which measurements of the highest accuracy can be made has been the greatest boon to engineers. It is not surprising, therefore, that electrical machines have gradually been evolved the efficiency of which approximates to a hundred per cent. No one appreciates more highly than the electrical engineer the value of scientific research, and no one takes a keener interest in every discovery in pure science.

Many of the reminiscences given by speakers at the commemoration meetings carried us back to the earliest days of the industry. It has to be remembered that the incandescent lamp was invented and the first telephone exchange was built only 44 years ago. Many of the speakers, therefore, had watched the growth of the industry from the start. Several tales were told of the founding of the Institution. It was pointed out that the ideas underlying any new movement are usually present in a vague way in the minds of many people and, therefore, it is difficult to assign the credit for the original idea with any degree of certainty. We think that greater stress might have been laid on the work done by Lord Lindsay—afterwards the Earl of Crawford and Balcarres—in founding the Society. He had a laboratory in a slum called Eaton Place (now swept away), lying between Green Street, Grosvenor Square, and Oxford Street. Some of the apparatus used is still in use at Faraday House, a college and testing institution which he helped to establish in 1889. It was in this laboratory that the first inception of founding a Telegraph Society was made in 1869. Cromwell and Arthur Varley, who worked in it, were anxious that the Society should be started at once, and they particularly wished that Sir William Thomson, who was then the leading electrical expert, should be the first President. It was not, however, until 1872 that the Institution got under way, the first President being Dr. Carl Siemens (Sir William Siemens). In 1874 Sir William Thomson became President for the first time, Lord Lindsay being one of his Vice-Presidents.

Listening to the speakers brought vividly back to the memory the halo of wonder that surrounded many of the early discoveries. The telephone, invented by Alexander Graham Bell, is regarded to-day as a mere domestic appliance. In 1876 the fact that you could hear a whisper at a distance of ten miles was rightly regarded as an almost supernatural achievement. Mr. Kingsbury recalled that Bell and his associates stated in 1877 in their first business circular that they were "prepared to furnish telephones for the transmission of articulate speech through instruments not more than 20 miles apart." To-day conversation has taken place over 5000 miles, and if the necessity ever arose an Indo-European telephone could be made without the need of further research.

Mr. Judd, who has been intimately connected with submarine telegraphy for more than 50 years, pointed out that notwithstanding the fact that hundreds of thousands of miles of submarine cable are now in existence, yet so well had the foundations of the industry been laid by British engineers and men of science that the cables of to-day are of the same general type as in 1866. Sir William Thomson solved the problem of operating submarine cables, first with the mirror galvanometer and then with the siphon recorder. Both instruments remain practically unaltered. The first great change in cable operation was the introduction of duplex working by which messages could be sent simultaneously from both ends of the cable. Judd was convinced that submarine telegraphy would continue to play the *rôle* assigned to it by the early pioneers of drawing together all the nations of the world.

Col. Crompton began electrical work 44 years ago by installing Gramme dynamos and Serrin lamps. He said that he had to learn the technicalities of his art from the telegraph engineers. Accustomed to working with primary batteries they told him that the resistance of the armature should never be less than the resistance of the external circuit. In the year 1883, as the result of an escape of gas, the Ring Theatre in Vienna was burned down with a lamentable loss of life. The Austrian Emperor issued an order that gas lighting would not be allowed in any of the Imperial Theatres. The Vienna Gas Company, therefore, decided to take up the supply of electric light, and they invited Col. Crompton to assist in the design and erection of their Central Supply Station. This installation was the prototype of many central stations built in this country in the early 'nineties.

Mr. Partridge narrated how the Earl of Crawford and Sir Coutts Lindsay installed a portable electric light plant in a yard behind the Grosvenor Gallery in 1883. From this small beginning emerged the Grosvenor Gallery Station, which was the first to adopt the parallel system of using transformers, thus revolutionising all the methods then in use. This station was burned down in 1890. In this year, after overcoming many difficulties, Ferranti successfully transmitted electric power at 10,000 volts from Deptford to Trafalgar Square.

Sir Charles Parsons gave an interesting account of the first turbo-alternator. This machine ran at 18,000 revolutions per minute, the armature of the dynamo being less than three inches in diameter. It was essential to have the diameter small, as otherwise the centrifugal forces called into play would have been prohibitively high. These small machines were used on board ship; they were far from economical, but they worked satisfactorily for several years. The modern large turbine-driven generator constructed on the lines of Parsons' inventions is the most economical generator of electricity from steam at present in existence. All the proposed "superpower" steam stations will be equipped with these sets.

Sir Oliver Lodge directed attention to the invaluable pioneering work in electrical theory done by Oliver Heaviside, who has shown how to calculate the eddy-current losses in cores, and the effects pro-

duced by high-frequency currents in cylindrical wires. His most important discovery, however, was that of the distortionless circuit, a discovery which led to most important practical developments in long-distance telephony both in land and in submarine cables.

References were made to the discovery of X-rays, of radio-telegraphy, and of the atomic nature of electricity.

The Institution of Electrical Engineers has been fortunate in having so many eminent men of science as Presidents in its early days. Lord Kelvin was President three times, and John Hopkinson was President twice. Amongst others we may mention Sir William Crookes, Sir Joseph Swan, and D. E. Hughes. The wonderful physical insight of Sir William Crookes is only now being fully recognised. Many years ago he had visions of electrons and even considered the possibility of isotopes.

The Institution was founded in order to promote the general advancement of electrical and telegraphic science. In its Journal many important scientific and mathematical papers have been published. In conjunction with the Physical Society of London it has published, at considerable expense, *Science Abstracts* for the past 24 years. Its activities are ever widening and we congratulate it on its well-merited success.

The American Association at Toronto.

THE second Toronto meeting of the American Association for the Advancement of Science and of the associated scientific societies, which was held during the last week of 1921, at the invitation of the University of Toronto and of the Royal Canadian Institute, was the seventy-fourth meeting of the association. It was successful in every way, and must go on record as the most satisfactory meeting thus far held, apart from the greater four-yearly meetings. Fourteen sections of the association were represented and twenty-six associated societies. About nine hundred addresses and papers were presented, and the official registration showed an attendance of 1832 persons. The sessions were held in the buildings of the University, which are excellently adapted for such purposes, while the majority of those in attendance were very conveniently housed in the University dormitories. These arrangements proved to be unusually convenient and satisfactory.

On the afternoon of Monday, December 26, the day before the official opening, the secretaries of the sections met with the general secretary and the permanent secretary to discuss some general problems of the association. On Tuesday afternoon Dr. F. R. Moulton, professor of astronomy in the University of Chicago, showed some very fine motion pictures on scientific subjects, illustrating the use of motion pictures in education.

The meeting was formally opened on the evening of Tuesday, December 27, under the able presidency of Dr. E. H. Moore, professor of mathematics in the University of Chicago. The president was introduced by the retiring president, Dr. L. O. Howard, chief of the Bureau of Entomology of the United States Department of Agriculture, who was permanent secretary of the association for many years. Sir Robert Falconer, president of the University, delivered an admirable address of welcome, emphasising the close and friendly relations that have so long obtained between Canada and the United States. This was followed by the address of the retiring president. In the first part of his address, among other interesting things, Dr. Howard directed attention to the fact that the average age of the presidents of the British and of the American Associations since 1895 is about the same, sixty-one years and eleven months for the British and sixty-one years and five months for the American. The second part of Dr. Howard's address dealt with the topic "The War against the Insects." It was pointed out that unceasing warfare must be waged by mankind against the almost countless and omnipresent forms of insect-life, which threaten the very existence of the human race. A report of the latter part of the address appeared in NATURE of January 19, p. 79. The opening sessions were followed by a reception in the room behind Convocation Hall, where members and their friends had an opportunity to meet one another and to examine the fine series of exhibits of scientific apparatus and products brought together by the local sub-committee on exhibits, of which Prof. E. F. Burton was chairman.

The Wednesday evening session in Convocation Hall was of a twofold character. Dr. W. Bateson, director of the John Innes Horticultural Institution, Merton Park, Surrey, who was present at Toronto by joint invitation of the American Association and the American Society of Zoologists, delivered a stimulating address on "Evolutionary Faith and Modern Doubts." He clearly emphasised the point that students of evolution harbour no doubts as to the fact of evolution, but the exact mode of evolution remains still an unsolved problem. He dwelt on the important progress recently made in America in relation to inheritance and the problems of genetics, especially with reference to chromosomes.

At the close of this address the session was transformed into a convocation of the University of Toronto, Sir Robert Falconer presiding, and the degree of Doctor of Science *honoris causa* was conferred on Dr. Bateson, Dr. Howard, and Dr. Moore. A reception followed the convocation.

Sir Adam Beck, chairman of the Hydro-Electric Power Commission of Ontario, addressed a general session on Thursday afternoon under the auspices of Section M (Engineering). His subject was "Hydro-Electric Developments in Ontario," and he showed a series of moving pictures illustrating the various hydro-electric projects in Ontario.

The Thursday evening conversazione in Hart House was one of the greatest social functions ever held in Toronto, and was unique in the history of the association. For three hours the two thousand guests of the University and the Royal Canadian Institute enjoyed the entertainment facilities of the magnificent students' social centre in Queen's Park.

The weather throughout the meeting was fine, though cold enough to be stimulating, and with an almost unclouded sky. The necessity for using artificial ice for winter sports in Toronto furnished an agreeable surprise to those who had anticipated arctic cold.

The Toronto meeting was especially international in character. It emphasised the point that the American Association is an international organisation. Although the majority of its members are now residents of the United States, it was clearly seen at Toronto how much the future of the association depends upon Canadians. The meeting was an occasion for a pronounced increase in the Canadian membership, and it is hoped that the time will soon come when Canadian men of science will all regard the association as theirs. A wonderfully fine

spirit of international good-fellowship and understanding prevailed throughout the meeting.

Sixteen well-attended dinners were held during the meeting by the various groups of scientific workers. The programmes of the sections and of the societies associated with them were generally extensive, and all were interesting and important. Many vice-presidential and presidential addresses were given and many symposia held. Special mention should be made here of the fine programme of Section M (Engineering) and of the symposium on an international auxiliary language, which was arranged for Toronto under the auspices of Section K (Social and Economic Sciences). The engineering programme was unusually excellent in many ways. Arrangements for this were due to the very efficient work of Mr. J. B. Tyrrell, of Toronto, vice-president of Section M. The Society for the Promotion of Engineering Education met with Section M.

The social and economic sciences (Section K) had no separate programme, but through the enthusiastic and efficient work of Dr. F. G. Cottrell, of the U.S. National Research Council, a symposium on an international auxiliary language was arranged. This was held at a joint session on Friday afternoon of Sections K and Q (Education). The symposium was preceded by the address of the retiring vice-president of Section K, Dr. F. L. Hoffman, of the Prudential Life Insurance Co. of America, on "The Organisation of Knowledge."

A programme of great general and cultural interest was presented by the Committee on the History of Science in a session held on Thursday morning. Among others, Dr. J. P. McMurrich—afterwards elected president of the association for 1922—gave a paper on the artistic anatomical work of Leonardo da Vinci.

The extraordinary success of the meeting was due mainly to the tireless and varied activities of the members of the local committee under the chairmanship of Prof. J. C. Fields, who foresaw all needed arrangements and added many pleasant and convenient details. Especially was praise given to the very artistic official badge, which will serve as a worthy commemoration of one of the most satisfactory meetings of the association. The very onerous and pressing work of caring for the publication of the general programme was undertaken by Dr. J. P. McMurrich, who handled this very difficult and confusing complex of details with very great skill. The University of Toronto Press gave very efficient service in this connection.

Publicity was unusually well handled. The recently organised Science Service co-operated with the association in arousing public interest in the meeting through the daily press. Dr. E. E. Slosson, editor of Science Service, and Mr. Watson Davis were present throughout the meeting on behalf of Science Service. Besides the valuable publicity work of Science Service, which is under the control of the American Association, the U.S. National Academy, and the U.S. National Research Council, and which operates for the sole purpose of disseminating scientific knowledge through the newspapers, just as valuable and efficient publicity work was accomplished by the local Sub-Committee on Publicity, of which Prof. A. G. Huntsman was chairman.

At the council meeting of the association the sum of 4000 dollars was allocated in grants for research, according to the recommendations of the committee on grants. Prof. B. K. Emerson, of Amherst, Mass., and Prof. E. A. Smith, of the University of Alabama, were elected to emeritus life-membership on account of the Jane M. Smith Endowment Fund. On a vote by the council the president appointed the following committee to consider the subject of reciprocity between the United States and Canada so far as this concerns scientific work:—E. L. Nichols (chairman), F. D. Adams, T. C. Chamberlin, J. C. Fields, and J. C. Merriam. It was decided that the next annual meeting of the association should be held at Boston, Mass., on December 26–30, 1922, and the 1923–24 meeting at Cincinnati, Ohio, in December 1923.

Dr. J. P. McMurrich, professor of anatomy in the University of Toronto, was elected president of the association. The following vice-presidents of the several sections were elected:—A (Mathematics), G. A. Miller, University of Illinois; B (Physics), Frederick A. Saunders, Harvard University; C (Chemistry), W. Lash Miller, University of Toronto; D (Astronomy), Otto Klotz, Dominion Observatory, Ottawa, Ontario; E (Geology and Geography), Charles P. Berkey, Columbia University; F (Zoological Sciences), Maynard M. Metcalf, Oberlin College; G (Botany), Francis E. Lloyd, McGill University; I (Psychology), Raymond Dodge, Wesleyan University; K (Social and Economic Sciences), Henry S. Graves, Washington, D.C.; L (Historical and Philological Sciences), William A. Locy, Northwestern University; M (Engineering), George F. Swain, Harvard University; N (Medical Sciences), Francis W. Peabody, Harvard Medical School; and O (Agriculture), R. W. Thatcher, University of Minnesota.

BURTON E. LIVINGSTON.

The Use of Light as an Aid to Aerial Navigation.

AT the meeting of the Illuminating Engineering Society on January 31, Lt.-Col. L. F. Blandy, who is associated with the Air Ministry, delivered a paper on "The Use of Light as an Aid to Aerial Navigation." Gen. Sir Frederick Sykes, Controller-General of Civil Aviation, presided. In the introductory portion of the paper the author described the lighting of the passengers' accommodation and crew's quarters, etc., on a modern airship, the light being derived from electric lamps fed from a generator driven by the engine. Small candle-power lamps are used for illuminating the dials of instruments, etc., on some machines. The external lighting of aircraft has been closely studied by the International Air Convention, which has defined precisely the equipment of a forward white light of 8-km. range, a red light of at least 5-km. range on the left hand, and a green light of similar range on the right. Special arrangements must be made to prevent the green light being seen from the left side or the red light from the right. A white rear light is also provided.

In navigating the air, principles similar to those in use at sea are thus being adopted for external lights, but owing to the motions of aircraft and their high speed the arrangement of navigation lamps demands special care. The relative speed of approaching machines may attain 200 m.p.h., *i.e.* 3·3 miles per minute. From the time of sighting headlights to the moment of collision the time available may be only 90 seconds, and it looks as though the range of navigation lights may have to be increased. Lights used by aircraft to facilitate landing may be either chemical or electric. Gas-filled electric lamps of 1000–2000 c.p. have been developed for this purpose, and appear to have some advantages over flares, notably as regards ease of control and extinction at will. Aerodrome lighting includes lights used to define the positions of buildings and other obstruc-

tions, illumination of the actual ground, and fixed illuminated signs to show the position of wind, etc. At Croydon the lighting of high wireless masts, which form dangerous obstructions, has been effected by placing 1000-c.p. gas-filled lamps, screened red, on the top of the masts. These form a good recognition mark.

Ground illumination requires special care to avoid dazzling the eyes of pilots at some angles. A special arrangement recommended at the International Air Convention is the use of lights arranged in the form of two "L's" to indicate positions for "taking off" and landing. Such lights were originally mounted in reflectors covered by flat glass discs in such a way that they were readily visible from above, but invisible at close range. Better methods of diffusion, enabling lights to be seen at all angles, have since been devised. Searchlights appear helpful, but have to be used with care to avoid confusing shadows when the machine is near the ground. An appendix to the paper contains particulars of the recommendations of the International Air Convention in regard to signals of distress, etc. Much has yet to be done in this new field, but the paper affords a useful review of existing procedure.

The Preservation of Stone.

A LECTURE to the Royal Society of Arts on the above subject by Mr. Noel Heaton is published in the Journal of the society for December 30 last. The lecturer gave an account of the various attempts which have been made to solve the important problem of preventing the decay and disintegration of stonework in buildings. The great majority of modern stone buildings, and a still greater proportion of medieval buildings, are constructed of limestone or sandstone, and the problem centres around these varieties rather than about the more resistant granite, used only to a limited degree. The causes of disintegration may be natural, depending on fluctuations of temperature, on rain, on erosion by wind, and, in ferruginous sandstones, on oxidation. Minute differences in structure often cause great differences in durability. The growth of vegetation on stone usually hastens decay. The most potent cause of decay is, however, the "unnatural" action of sulphuric acid, derived from coal-smoke, coupled with the accumulation of soot and grime. Sir Frank Baines, who introduced the lecturer, stated that, roughly, 80,000 tons of sulphuric acid are thrown annually into the London atmosphere. Strain set up by the rusting of iron is also a contributory cause of decay. The lecturer then turned to the means of preventing decay.

An indirect method of preventing decay is to further, by every possible means, the campaign against atmospheric pollution. The stone may be treated with preservatives, which were divided into three groups: (*a*) those acting merely as surface coatings; (*b*) those impregnating the stone without chemical action; and (*c*) those operating by chemical reaction with the stone. In the first class are paint and limewash, the latter being useful where the stone is subjected to a moist atmosphere, but protected from rain. In the second class are mineral wax applied by heat or in solution in benzene, drying oils, creosote, or gelatinous precipitates formed on the stone. The first process is very old, and is effective for certain purposes. Treatment with alum solution, followed by soft soap, which results in the precipitation of an aluminium salt of the fatty acids, is recommended.

In the third class treatment with baryta is effective in repairing a stone disintegrated by sulphuric acid. A common method is the deposition of silica or silicates. Treatment with waterglass leads to unsightly efflorescence. This may be reduced by treating with a solution of arsenic acid after the waterglass, but the most satisfactory results are obtained with silicofluorides, introduced in France by Kessler in 1883. A solution of magnesium silicofluoride reacts with limestone:

$$MgSiF_6 + 2CaCO_3 = SiO_2 + MgF_2 + 2CaF_2 + 2CO_2.$$

The solution, known as "Fluate," is manufactured in France, and the lecturer stated that, although the results were conflicting, it appeared to be beneficial. In America the double salts of magnesium and zinc were preferred. The use of the solution has recently been investigated by Prof. Desch, in conjunction with the Department of Scientific and Industrial Research, and, although the detailed results have not yet been published, the conclusions appear to be that too strong a solution should not be used (not stronger than 10 per cent.), and that the mode of application should be adjusted to particular conditions. The method is most useful on new work. The use of nostrums of unknown composition is strongly condemned, as they may cause great injury. Sir Frank Baines also contributed some valuable information in the discussion on the lecture.

Mathematics in Japan.

A GOOD many years ago there was an exhibition at Earl's Court in which the Japanese Government and nation took a conspicuous part. For several reasons the Japanese art section was particularly interesting. It contained priceless and authentic specimens of their national painting and handicraft before they were influenced by foreign methods and ideals. Besides this, there were paintings by some of their modern artists who adopted Western methods and conventions. The contrast was very striking, and in some respects not very satisfactory.

Similar reflections are suggested by the present state of Japanese mathematics, as shown, for example, in various mathematical papers recently received from the University of Tokyo. Circumstances are different because mathematical science is now cosmopolitan, and no single nation can afford to neglect its various developments. At the same time, like nationality in drinks, there is a kind of nationality in science, art, or any other human activity, which is justifiable, and even instructive, if it is not carried to excess. We may notice it, for example, in the papers and treatises of the leading mathematicians, such as Klein and Dedekind on one hand and Poincaré, Hermite, and Darboux on the other. The elegance of the best French text-books is scarcely equalled, if at all, by those of any other nation; at the same time, the corresponding German works are distinguished by thoroughness, method, and fulness of references. The treatise on elliptic modular functions by Klein and Fricke and Poincaré's memoirs on Fuchsian functions illustrate the point.

It is difficult to be sure how far Japanese mathematics is entirely original. They had various approximations to π, some of which, at any rate, seem to have been of their own invention. They had an extraordinary gift for solving numerical equations of high degrees by approximation, and one Japanese writer appears to have anticipated many of Steiner's

theorems on poristic systems of circles. Besides this, they discussed elegant problems more or less suggested by familar objects, such as fans, toys, etc.

It would be a pity if all truly Japanese characteristics were to become obliterated. Apart from æsthetic considerations, if they avoid falling into the rut of Western methods there is a chance of their producing something really novel and suited to their genius. They might, for instance, solve some of the outstanding problems of group theory or make some notable advance in Diophantine analysis—a subject which seems to have lost its fascination for most European mathematicians.

The attitude of an individual towards foreign mathematics is sometimes peculiar, and even amazing. Not very long ago an English lady spending a holiday at Utrecht was introduced to an eminent Dutch mathematician. Having a mathematical friend in England, she asked the professor his opinion of English mathematicians. The answer was to the effect that their work was so strangely insular that he could not spare the time to make himself familiar with it. This was after Cayley, Sylvester, and Salmon had published much of their best work on invariant theory.

G. B. M.

University and Educational Intelligence.

CAMBRIDGE.—In connection with the meeting of the Royal Agricultural Society at Cambridge in the coming summer, honorary degrees are proposed for H.R.H. Prince Albert, the President of the Society, Mr. C. R. W. Adeane, Sir Gilbert Greenall, Sir A. Daniel Hall, Mr. E. S. Beaver, Mr. A. E. Humphries, Mr. Ernest Mathews, and Mr. G. P. Hawkins.

An open Fellowship, for which all graduates of the University are eligible who took their first degree not earlier than June 1919, is announced by King's College. Any one who wishes to offer himself as a candidate should communicate with the Provost as early as possible.

LEEDS.—Prof. Sir Berkeley Moynihan has given to the University an endowment for the annual award at the Leeds Medical School of a gold medal to the best student of the year in Medicine and Surgery. In accordance with Sir Berkeley Moynihan's wish the gold medal will bear the name of William Hey in commemoration of the work of that great Leeds surgeon. The Council of the University in accepting the endowment have recorded their thanks to Sir Berkeley Moynihan for his generous gift. William Hey (1736–1819) was one of the pioneers of modern surgery. A brilliant operator and teacher, he established the tradition of surgical skill which has ever since been one of the chief distinctions of Leeds. He was a friend of Joseph Priestley when the latter was Minister of Mill Hill.

LONDON.—The following course of free public lectures is announced: At King's College, Strand, at 5.15 on Wednesdays, March 8, 15, and 22, "The Quantum Theory of Radiation and the Constitution of the Atom," Prof. Nils Bohr (in English)

THE bearing of improved means and methods of education receives striking confirmation in the figures adduced by Mr. Percival Sharp in his address in January at the annual meeting of the Association of the Directors and Secretaries for Education held in the County Hall, London. Dr. Sharp submitted official statistics for England and Wales showing the curve of crime from 1870, when the population of England and Wales was 22,000,000, down to 1919, when it had reached nearly 37,000,000. In 1870 107,621 men and 39,604 women above sixteen years of age—a total of more than 147,000 persons—were committed to prison. In 1919 the numbers fell to 22,289 men and 8718 women—a striking difference, having regard to the great increase in population. There are no figures available earlier than 1893 concerning indictable offences tried at the Quarter Sessions. The number of men convicted shrank in 1919 to 5200, as compared with 8200 in 1893, whilst the number of women convicted declined from 1245 in 1903 to 826 in 1919. The number of men tried summarily for indictable offences fell from 20,000 in 1893 to 16,000 in 1919, and of women from 5000 to 3900. The figures for non-indictable offences fell from 133,000 to 73,700 for men in the same years, and from 43,000 to 18,000 for women. The Home Office has decided to close eight prisons and to shut down the female wings of six other prisons at the end of March next. So far as a great industrial and commercial area like Manchester is concerned, two large industrial and reformatory schools have recently been closed, and the returns available show that between 1907 and 1921 the number of children under maintenance shrank from 659 in 1909 to 209 in 1921. These figures are conclusive as to the value and influence of education in the training of the children of the nation, and condemnatory of any proposed legislative measures of economy with regard to the restriction of such training. Rather they enforce the necessity for continued development and improvement.

A LIST of students from the King's Dominions overseas and from foreign countries studying in the universities and university colleges of the United Kingdom has been compiled by the Universities Bureau of the British Empire. The following figures gleaned from the list are of general interest, which would, however, be greatly enhanced if to them could be added statistics of the very numerous students from abroad who are studying at the Inns of Court, in other professional and technical institutions not included in universities and university colleges, and privately:—Of the total number, 4470, Asia contributed over a third (1576), Africa 1187, America 781, Europe 645, and the Pacific, 281. Of the Asiatics 1240 are from India, Burma, and Ceylon; this includes 446 at London, 173 at Edinburgh, 171 at Cambridge, 170 at Oxford, and 65 at Glasgow. The Indian Students' Department of the Office of the High Commissioner in 1921 estimated that there were 1500 Indian students at the universities and technical colleges and 600 at the Inns of Court. From China came 143, of whom 49 are at London, 25 at Edinburgh, and 17 at Cambridge. Of 73 from Japan 55 are at London. South Africans and Rhodesians number 832, including 327 at London, 178 at Edinburgh, 95 at Dublin, 82 at Oxford, and 42 at Cambridge. Of 294 from Egypt, 88 are at London and 52 at Birmingham. The U.S.A. contributed 400, of whom 210 are at Oxford, a large proportion being Rhodes scholars. Of 200 from Canada, 87 are at Oxford. South America contributed 75 and the West Indies 101, of whom 33 are at London and 23 at Edinburgh. Of the Europeans, 91 are from Russia, 61 from Switzerland, 62 from France, 52 from Greece, 70 from Scandinavian countries, 49 from Rumania, and 48 from the kingdom of the Serbs, Croats, and Slovenes. Of 178 Australians, 50 are at Oxford, 41 at London, 36 at Edinburgh, and 35 at Cambridge; while of 102 New Zealanders, 27 are at London, 25 at Edinburgh, 24 at Cambridge, and 20 at Oxford.

Calendar of Industrial Pioneers.

March 2, 1892. Sir John Coode died.—A pupil of J. M. Rendel, Coode became resident engineer, and then engineer-in-chief, of the Portland breakwater, completed in 1872, and afterwards rose to be the most distinguished harbour engineer of his time. Among his greatest works were those at Cape Town, Fremantle, and Colombo. From 1889 to 1891 he served as president of the Institution of Civil Engineers.

March 3, 1895. Alfred Giles died. March 4, 1847. Francis Giles died.—Both the Giles, father and son, were successful civil engineers. Francis Giles was employed under Rennie, and later carried out various important harbour and canal works; while his son was largely concerned with railway projects in Denmark, France, Canada, Galicia, and other countries. In 1893 Alfred Giles was president of the Institution of Civil Engineers.

March 4, 1902. Bryan Donkin died.—The grandson of Bryan Donkin (1768–1855), known for his pioneering work in paper-making machinery, Donkin succeeded to the business founded by his grandfather. He was, however, best known for his study of thermodynamics and the scientific testing of steam engines, his investigation of steam jacketing and condensation, and his work on gas and oil engines.

March 6, 1900. Gottlieb Daimler died.—A native of Würtemberg, Daimler became a practical engineer, worked in England under Whitworth, and about 1870 became associated with the gas-engine pioneer Nicolas Otto. In the 'eighties he constructed small internal-combustion engines, one of which he fitted to a bicycle, and in 1890 he founded the Daimler Motorengesellschaft at Cannstadt, where he died.

March 7, 1809. François Blanchard died.—One of the most celebrated of the early aeronauts and a reputed inventor of the parachute, Blanchard made some sixty ascents. On January 7, 1785, with Dr. John Jeffries, he was the first to cross the Channel in a balloon. His wife, Sophie Armant, was also an intrepid aeronaut, and perished in a balloon accident in 1819.

March 8, 1803. Francis Egerton, Duke of Bridgewater, died.—The Duke of Bridgewater has been called the founder of British inland navigation. Succeeding to the family estates at an early age, he settled in Lancashire, and to develop his collieries engaged Brindley to construct the canal from Worsley to Manchester and that from Manchester to the Mersey, the first English canals.

March 8, 1887. James Buchanan Eads died.—Born in Indiana in 1820, Eads's whole life was bound up with the Mississippi. He made a fortune by raising steamboats sunk in the river, achieved a great reputation during the Civil War by the rapid construction of gunboats for its defence, in 1867–74 constructed the great steel arch bridge which spans it at St. Louis, and later originated the jetties at its mouth for improving the channel. He was the first American to be awarded the Albert medal of the Royal Society of Arts.

March 8, 1889. John Ericsson died.—A fertile inventor, a noted engineer, and one of the foremost constructors of warships, Ericsson was a native of Sweden. From 1826 to 1839 he was in England, where he produced the first steam fire-engine, constructed the locomotive "Novelty," and built the screw-driven vessel *Robert F. Stockton*. The remainder of his life was spent in America, where during the Civil War he inaugurated the era of the armoured turret battleship. The great fight between Ericsson's *Monitor* and the *Merrimac* took place on March 9, 1862.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, February 23.—Sir Charles Sherrington, president, in the chair.—C. D. **Ellis**: β-Ray spectra and their meaning. A method of finding the wave-lengths of γ-rays of too high a frequency to be measured by the crystal method depends on the fact that γ-rays are converted into β-rays according to the quantum relation. If the energies of the groups of electrons ejected by γ-rays be added to the work done in removing the electron from inside the atom to the surface, $h\nu$ is obtained. The work is found from observations of the energies of corresponding groups excited in different substances, and the method is applied to find the wave-lengths of the γ-rays emitted by radium B, radium C, and thorium D. The energies of the β-ray groups of thorium D have been measured for this purpose. The γ-rays are emitted from the nucleus and the numerical values of the wave-lengths suggest that the quantum dynamics applies to the nucleus and that part of the structure can be expressed in terms of stationary states. Suggestions for the energy of these stationary states in radium B and thorium D nuclei are given.—A. E. **Conrady**: A study of the balance. The first weighings by the Gaussian method of exchange made with an inexpensive analytical balance gave a probable error of only 0·004 mg. A constructional fault in the suspensions was remedied and the probable error fell to 0·0013 mg. A further systematic error, depending on the sequence of pointer readings in successive exchanges was attributed to imperfect elasticity and irregular curvature of knife-edges. A method of double exchange of loads which, by close adjustment of a light rider, caused all readings to fall on two alternating positions of rest, brought the probable error to 0·0008 mg., and it seemed now largely due to irregular air-currents. Arrangements allowing manipulation of loads without opening of balance case reduced the probable error to an average value of 0·0004 mg. If the centre of gravity of the moving parts falls in the supporting line of the central knife-edge ("autostatic" state), the reading of the pointer becomes independent of levelling of the balance case, and highly accurate results can be obtained on very infirm supports.—J. S. **Owens**: Suspended impurity in the air. The essential part of a new instrument for measuring impurities is a fine jet of air which strikes a glass surface with high velocity, depositing its dust thereon. The velocity of jet affects the operation of the instrument. The adhesion of dust to the glass has suggested applications which indicated (*a*) that visibility is usually a function of amount of suspended impurity; (*b*) that suspended dust travels over great distances; records being described of dust from the Continent; (*c*) that the microscopical examination of such records indicates differences depending upon wind direction.—R. V. **Southwell**: On the free transverse vibrations of a uniform circular disc clamped at its centre; and on the effects of rotation. An analysis of the influence of rotation upon the normal modes and frequencies of free transverse vibration in a uniform circular disc, complete freedom from constraint being assumed, is extended to cover the effects of constraints which prevent, along a small circle concentric with the free edge, the occurrence either of finite transverse displacement w, or of finite slope $\delta w/\delta r$. The constraints are assumed to have no effect upon the centrifugal stress-system. Clamping a non-rotating disc along a small circle produces only slight changes of frequency in modes characterised by two or more

nodal diameters, but is important in its effect on the "symmetrical" modes and on modes having one nodal diameter. In the other extreme case, when the flexural rigidity may be neglected, the central constraint has no effect upon the natural frequencies. In the general case, in which both flexural and centrifugal stresses are considered, the gravest frequencies in modes which have nodal diameters may be calculated by the formula previously given; a special investigation is made of the gravest frequency in a symmetrical mode.—A. E. **Oxley**: Magnetism and atomic structure. II.—The constitution of the hydrogen-palladium system and other similar systems. The susceptibility of palladium black charged with hydrogen is less than that of pure palladium black. From this it is concluded that the occluded hydrogen is neither in the atomic nor molecular state. The results agree with the existence of a chemical compound, probably Pd-H. In the hydrogen molecule, each atom thrusts its electron into the other atom, the bond being represented by a pair of electrons held in common. The palladium atom has 46 electrons, the hydrogen atom 1 electron, the latter being thrust into the outer shell of the palladium atom. If these 47 electrons take up a configuration like that of the silver atom (atomic number 47), which is diamagnetic, the fall of susceptibility may be accounted for. Paramagnetic manganese fused in hydrogen becomes ferro-magnetic. The occluded hydrogen atoms probably thrust their electrons into the outer shells of the manganese atoms, producing in them electron configurations analogous to that of the iron atom.—T. **Carleman** and G. H. **Hardy**: Fourier's series and analytic functions. If $f(\lambda)$ is integrable in the interval $(0, 2\pi)$, and the associated function $\phi(u) = \frac{1}{2}\{f(a+u)+f(a-u)\}$, where $0<a<2\pi$, is harmonic and bounded in a certain neighbourhood of $u=0$, then the necessary and sufficient condition for the convergence of the Fourier series of $f(\lambda)$, at $\lambda=a$, is that $\phi(u)$ should tend to a limit when u tends to zero through positive values.—A. **McAulay**: Multenions and differential invariants. Pts. II. and III. The quadratic form is introduced: all multenion formulae may be put into invariant form. Tests, both by finite and by infinitesimal transformation, are given, for ascertaining whether invariance of each one of six types subsists for any given function. Multenion methods are compared with those of the Theory of Tensors and details are furnished for translating from one mode of presentation to the other. Pt. III. is a general survey of the applications of a Riemann manifold to relativity. In relation to matter and gravitation no new principle is introduced but the electro-magnetic field is treated in a novel manner. The scalar and vector potentials are wholly ignored. The application to matter in bulk is kept in mind, and it is considered imperatively necessary to adapt relativity methods to a sufficiently general set of relations as at least to leave Maxwell's explanation of crystalline reflection, refraction, and transmission of light intact.

Linnean Society, February 16.—Dr. A. Smith Woodward, president, in the chair.—R. R. **Gates**: The inheritance of flower size in plants. Reciprocal crosses were made between *Œnothera rubricalyx* and *Œ. biennis*, with petals 40 mm. and 20 mm. in length respectively. The size of flowers in F_1 was intermediate and relatively uniform. In F_2 there was a marked difference in size of flowers (*a*) on different plants, (*b*) in different flowers of the same plant, and (*c*) sometimes in the different petals of a flower. Measurements on F_3 and F_4 plants show that the hypothesis of several Mendelian factors for length of petal is an insufficient explanation. Variation curves show a tendency to segregation in flower-size between different plants, but also a tendency for the occurrence of smaller flowers, some petals being only 7 mm. in length. Segregation is therefore not confined to germ-cell formation, and is not Mendelian. Probably cytoplasmic differences are involved in this type of inheritance and variation.—W. **Dallimore**: The effect produced by wind at Llandudno. Wind causes remarkable dwarfing of trees and shrubs on the exposed rocks of the Great Orme's Head.—J. L. **North**: The possible successful growth of *Glycine Soja*, Sieb. & Zucc., as a profitable crop in Great Britain. The flattening of the branches, the result of close sowing—the Chinese method—is retained even when plants are grown wide apart. Also if a plant starts at a wrong angle it twists itself upon its base to bring it into line with the other plants. By using the earliest ripening seeds of the previous year of a so-called German acclimatised plant earlier maturity has been obtained. Plants in 1914 ripened on November 28, while last year they reached a corresponding degree of ripeness early in September.

Royal Microscopical Society, February 15.—Prof. F. C. Cheshire, president, in the chair.—A. L. **Booth**: The microstructure of coal from an industrial standpoint. Microstructure can be applied to augment chemical analysis in fuel selection. Thin sections of bituminous coals can be classified as humic, spore, and cannel. These are arbitrary standards, thus the use of the microscope in industrial coal problems is purely empirical. For selection purposes an unknown coal is compared with coals of known properties. Little is known of the influence of the various coal constituents on the properties of coal. Chemical analysis does not necessarily give information as to the coal type. Much published work on coal lacks the essential common factor, the microanalyses, whereby the whole can be correlated.

CAMBRIDGE.

Philosophical Society, February 6.—Prof. A. C. Seward, president, in the chair.—H. Hamshaw **Thomas**: On some new and rare Jurassic plants from Yorkshire (V): Fertile specimens of *Dictyophyllum rugosum* L. and H. *Dictyophyllum rugosum* has been known since 1828 and its sporangia have now been found near Scarborough. They are similar to those of the modern ferns Cheiropleuria and Platycerium and confirm the suggested relationship to the Dipterineae.—F. A. **Potts**: On the food of Teredo, the shipworm. The Teredinidae are invariably found burrowing in wood. The minute fragments excavated by the rotating shells pass through the alimentary canal and are in part digested by it. The stomach has an enormous coecum which retains quantities of wood, but digestion takes place in the so-called "liver," some of the cells of which are gorged with particles of wood. In living tissue their amoeboid pseudopodia are active and many of the cells are detached and float freely in the lumen. There are no commensal organisms assisting in wood digestion and it seems unlikely that plankton forms play any significant part in the nutrition of these molluscs.—E. H. **Neville**: The definition of an envelope.

MANCHESTER.

Literary and Philosophical Society, November 29, 1921.—Mr. T. A. Coward, president, in the chair.—F. T. **Peirce**: Electromagnetic valency and the radiation hypothesis. A magnetic doublet, consisting of two electrons in small orbits (ring or vortical electrons), furnishes a probable physical basis for a

radiation hypothesis of chemical reactivity, and suggests the following results for non-electrolytes:— The bond can be broken only by radiation of definite frequency ν, the most intense impact resulting only in ionisation. External illumination as a criterion should be large for unimolecular decomposition or transformation, considerable for reversible reactions, especially the effect due to the radiation exciting the endothermic process, and inappreciable for irreversible combination. Corresponding frequencies are selectively absorbed or emitted. The energy change is double, corresponding to the attainment of the critical unstable equilibrium and of the normal stable state. For the complete change in intrinsic energy U, $-U = nH(\nu - \nu')$ per mol. The system can accumulate absorbed radiant energy up to a limit of one quantum per electron. It emits in quanta, but absorbs and scatters continuously. The frequencies and energy changes are altered by solvents, but not by intermediate compounds.

December 13, 1921.—Mr. T. A. Coward, president, in the chair.—Laura E. **Start**: Sea Dayak fabrics and their decoration. The patterns of part of the group of Iban cloths collected during the Cambridge Expedition to the East Indian Archipelago in 1899 are traditional. They are symbolical, and in some cases designate the rank or tribe of the wearer. Anthropomorphs, zoomorphs, and phyllomorphs form the chief motives, and of these the animal patterns predominate. For the origin of the life-history of patterns, in which man, the frog, the crocodile, the shrew, and the tiger are used symbolically, we must go back to the Proto-Malay stock, from which the Iban probably sprang, or consider the patterns a development due to the Ibans themselves.

January 6.—Joint Meeting with the Manchester Sections of the Society of Chemical Industry, the Institute of Chemistry, and the Society of Dyers and Colourists.—Dr. Edward Ardern in the chair.—A. **Harden**: Biochemical method. The methods and the difficulties of obtaining trustworthy results in biochemical research are due to the many factors which involve the living organisms. The occurrence of vitamins in foodstuffs, the differences between the various kinds of vitamins, the serious effects of ill-chosen diet for children, and the destruction of vitamins by heat and contact with air were discussed.

Society of Glass Technology, February 15.—The president, Dr. M. W. Travers, in the chair.—F. W. **Hodkin** and W. E. S. **Turner**: The relative advantages and disadvantages of limestone, burnt lime, and slaked lime as constituents of common glass batches containing soda ash and saltcake. Pt. II. The rates of melting depend upon the form of alkali and lime used as well as the relative amounts of lime and soda used. In the case of glass such as that used for bottles made on automatic machines, and containing about 8 per cent. of lime, the soda ash burnt lime batch appeared to be the most readily melted. With lime-containing glasses, the melting is assisted by the addition of small amounts of other oxides, particularly of magnesia. In the case of glasses containing about 12 per cent. of lime, the slaked lime containing batches generally melted most readily. A discussion followed the paper, and the remainder of the meeting was taken up with a debate on the subject of "The Melting of Glass." A number of questions on the subject had been submitted by members, and formed the basis of the discussion; this being continued from the Leeds meeting in November 1921, at the general request of members.

Diary of Societies.

MONDAY, MARCH 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. Ambrose and others: Discussion on E.H.T. Cable-testing.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.1), at 8.—S. N. Dasgupta: The Logic of the Vedanta.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Special and Business Meetings.

ROYAL SOCIETY OF ARTS, at 8.—Prof. A. F. C. Pollard: The Mechanical Design of Scientific Instruments (3).

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.

SURVEYORS' INSTITUTION, at 8.—B. P. Davies: The Analysis of Building Costs.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—C. E. N. Bromehead: The Influence of its Geography on the Development of London.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—W. Cullen: Gold Metallurgy of the Witwatersrand, Transvaal.

TUESDAY, MARCH 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire. Series I.—Racial Problems in Asia and Australasia (3).

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Major Sir Humphrey Leggett: Tanganyika Territory (formerly German East Africa).

ANGLO-SWEDISH SOCIETY (at Swedish Hall, Harcourt Street, W.1), at 5.30.—Dr. F. A. Bather: The Sea-lilies of Gotland and Dudley.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—N. S. Lucas: Report on the Deaths which occurred in the Society's Gardens during 1921.—F. Balfour Browne: The Life-history of the Water-Beetle *Pelobius tardus* Herbst.—Dr. R. Broom: The Temporal Arches of the Reptilia.—F. W. Urich, Dr. H. Scott, and Dr. J. Waterston: Note on the Bat-Parasite *Cyclopodia greeffi*, and on a new Species of Hymenopterous (Chalcid) Parasite bred from it.—S. K. Montgomery: Direct Development in a Dromiid Crab.

INSTITUTION OF CIVIL ENGINEERS, at 6.—A. C. Walsh and W. F. Stanton: The Improvement of the Port of Valparaiso.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7. H. W. Lee: A Chart for finding the Depth of Focus of a Lens.—H. Farmer: Direct Photography: a fully efficient alternative and addition to our present system.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—L. H. Clark and B. D. Watters: Comparisons between the Therapeutic, Photographic and Ionisation Effects of Ultra-Violet and of Beta Radiation.—E. E. Burnside: Apparatus for deep X-ray Therapy.

WEDNESDAY, MARCH 8.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 10 A.M.—Dr. G. D. Bengough: Notes on the Corrosion and Protection of Condenser Tubes.—At 2.30.—F. Adcock: The Internal Mechanism of Cold-Work and Recrystallization in Cupro-Nickel.—Research Staff of the General Electric Company: The Effect of Impurities on Recrystallization and Grain Growth.—Dr. H. Moore and S. Beckinsale: Further Studies in Season-Cracking and its Prevention. Condenser Tubes.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Baron F. Nopsca: The Geological Importance of the Atavistic Reptilian Fauna of the Upper Cretaceous of Transylvania.

ROYAL SOCIETY OF ARTS, at 8.—W. A. Appleton: The Proper Functions of Trade Unions.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—A. A. Remington: The Design and Function of Laminated Automobile Suspension Springs.

THURSDAY, MARCH 9.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 10 A.M.—Prof. C. A. Edwards and A. J. Murphy: The Rate of Combination of Copper and Phosphorus at Various Temperatures.—Dr. W. Rosenhain: Some Cases of Failure in "Aluminium" Alloys.—Prof. F. C. Thompson and E. Whitehead: Some Mechanical Properties of the Nickel-Silvers.—Dr. D. Hanson and Marie L. V. Gayler: A Further Study of the Alloys of Aluminium and Zinc.—A. Westwood: The Assay of Gold Bullion.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. M. Lefroy: The Menace of the Insect Pest: The Balance of Life in Relation to Insect Pest Control (2).

ROYAL SOCIETY, at 4.30.—Prof. T. R. Merton and S. Barratt: The Spectrum of Hydrogen (Bakerian Lecture).

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5. —W. H. Young: The Theory of Functions of Two Complex Variables. —Col. R. L. Hippisley: The Nodes of the Three Bar Sextic.—R. F. Whitehead: The Number of Solutions in Positive Integers of the Equation $yz+zx+xy=n$.—T. Stuart: The Determination of the Criterion to prevent "Hunting" in Hartnell's Governor.—N. Wiener: The Average Value of a Functional.—Lt.-Col. A. Cunningham: On Least Primitive Roots.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. M. Greenwood: The Influence of Industrial Employment on General Health (Milroy Lectures) (1).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss Coombs, Mrs. Bottrill, and others: Discussion on the Family Group System in Infant Schools.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—T. Smith and J. S. Anderson: A Criticism of the Nodal Slide as an Aid in Testing Photographic Lenses.—A. J. Bull: A Non-polarising Spectrophotometer.—J. Guild: The Photometry of Optical Instruments.—T. Smith: A Projective Treatment of the Submarine Periscope.—A. J. Dalladay: Some Measurements of the Stresses Produced at the Surfaces of Glass by Grinding with Loose Abrasives.

INSTITUTE OF METALS (London Section), (at Sir John Cass Technical Institute), at 8.—Dr. D. Hanson: Microstructure and Physical Properties of Alloys.

FRIDAY, MARCH 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—R. L. Smith-Rose: The Electromagnetic Screening of a Triode Oscillator.—Dr. H. P. Waran: A New Form of High Vacuum Automatic Mercury Pump.—W. N. Bond: Viscosity Determinations by means of Orifices and Short Tubes.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. T. R. Merton: Problems in the Variability of Spectra.

SATURDAY, MARCH 11.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (2).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

MONDAY, MARCH 6.

CITY OF LONDON (BOYS') SCHOOL, Victoria Embankment, at 5.30.—Miss Rosa Bassett: The Dalton Plan of Self-education (5).

UNIVERSITY COLLEGE, at 5.30.—A. R. Powys: The Preservation of Ancient Buildings.

TUESDAY, MARCH 7.

IMPERIAL COLLEGE—ROYAL SCHOOL OF MINES, at 5.30.—Col. N. T. Belaiew: The Crystallisation of Metals (3).

KING'S COLLEGE, at 5.30.—F. H. Rolt: Accurate Measurements in Mechanical Engineering: The Use and Testing of Gauges (4).

LONDON SCHOOL OF ECONOMICS, at 6.—Sir Josiah C. Stamp: The Administrative Factor in Government (4).

WEDNESDAY, MARCH 8.

EAST LONDON COLLEGE, at 4.—Prof. F. E. Fritch: Certain Aspects of Freshwater Algal Biology (4).

LONDON (R.F.H.) SCHOOL OF MEDICINE FOR WOMEN (Hunter Street, W.C.1), at 5.—Dr. H. H. Dale: Some Recent Developments in Pharmacology (3).

KING'S COLLEGE, at 5.15.—Prof. N. Bohr: The Quantum Theory of Radiation and the Constitution of the Atom (1).

HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (7).

UNIVERSITY COLLEGE, at 8.—The Current Work of the Biometric and Eugenics Laboratory (4). E. C. Rhodes: The Relation of Caries in the Teeth of School Children to Health and Home Conditions.

THURSDAY, MARCH 9.

INFANTS' HOSPITAL (Vincent Square, S.W.1), at 4.—Dr. W. M. Feldman: The Physiology of the Infant.

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. L. D. Barnett: The Hindu Culture of India (2).

UNIVERSITY COLLEGE, at 5.15.—Sir Robert Blair: The Education Programme of the Labour Party.—Prof. J. E. G. de Montmorency: Welsh and Irish Tribal Customs (5).

KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (8).

FRIDAY, MARCH 10.

METEOROLOGICAL OFFICE (South Kensington, S.W.7), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (8).

TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. C. Miller: The New Psychology and its Bearing on Education (7).

SATURDAY, MARCH 11.

LONDON DAY TRAINING COLLEGE, at 11.—Prof. J. Adams: The School Class (8).

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Cleopatra's Needle and Sun-worship.

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THURSDAY, MARCH 9, 1922.

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Awards for Discovery and Invention.

AN example of the changed conditions brought about by the policy of Government encouraging the application of science to industry will be found in the "Report of the Inter-Departmental Committee appointed to consider the Methods of dealing with Inventions made by Workers aided or maintained from Public Funds" (pp. 25, H.M.S.O., price 6*d*. net). Before the War this subject was dealt with by Departments in a manner which frequently caused workers to desire arbitrators who, if not more sympathetic, might at least have knowledge of affairs, and act in accordance with some guiding principles. There were three courses which might be adopted by Government Departments, involving complete control, control by Government with delegation of its rights to its contractors but leaving commercial use to the inventor, and finally release from any obligation, with freedom to deal with invention as the inventor pleased. In those days, however, the cases coming up for decision were few, and the number of individuals affected small, whereas now Government employs a large body of persons on scientific and technical work, any of whom may, at any time, produce an invention. The importance of such an invention, although emanating from a laboratory belonging to the Fighting Services, may be even greater from a civil than from a military point of view.

Urgency was imported into the consideration of the question when inventions of commercial value began to be produced by the Department of Scientific and Industrial Research. Regulations had already been framed by that Department by which, while the results of an assisted worker who has chosen some field for extending knowledge, are under no restriction as to publication, an obligation was imposed on him to consult the Department if he desired to make commercial use of his investigations. A patent might then be taken out in the joint names of the inventor and of an Imperial Trust, and the proportional interests of the Department, of the inventor, and of any co-operating bodies were determined by the Department. The inventor assigned all rights in the patent to the Imperial Trust, which it is understood found a difficulty in exploiting patented inventions commercially. Variation in treatment of the subject and the unsatisfactory nature of some of the prevailing conditions thus called for a settlement of the method of treating inventors aided or maintained from public funds, and of the method of utilising their inventions in industry.

The Report proceeds to consider the difficult subject of the ownership of inventions made in Government employment. It deals first with the case of research workers, and secondly with persons not specially employed on research, expressing the view that in connection with such questions as rewards and the enjoyment of commercial rights each case should be decided on its merits. It is clear from the context that, as regards inventions made by research workers, divergent views have been expressed by the numerous witnesses who have been called before the Committee, and the result of a consideration of these views is embodied in the following passage:—

"In the case of a research worker employed by Government, the view has been expressed that, since he is employed for the purpose of making investigations and is provided with equipment, accommodation and other facilities at the cost of the State, he should not, as a general rule, be entitled to a reward or to any rights in any invention made in the course of his duty. On the other hand, there is a feeling amongst scientific men that rewards for specially meritorious work would have the effect of encouraging further effort. While we are, on the whole, in agreement with the former view, we consider that these are questions which should be decided in the light of all the circumstances in each case, the general principle being that the invention is the property of the State, and that the reward to the inventor (either by way of a money grant or of a share of patent rights or otherwise) should be increased or diminished in proportion to the remoteness or proximity of the invention to the work for which he was engaged or for which he had special facilities or knowledge as the result of his employment."

From this statement it is apparent that the Committee appreciates that it would be unwise to lay down a rule governing all cases, and that in dealing with the question of rewards the merits of each individual case should be taken into consideration. To bring the matter to an issue certain principles are enunciated, the chief features of which are that a competent authority should define in the light of all the circum-

stances of the case the respective rights of the Government and of the inventor, and decide any reward to which he may be entitled; that where the rights in an invention capable of commercial exploitation belong to the Government, it should be exploited commercially for the benefit of the Government; and that the system of dealing with these matters should be uniform for all Government departments.

The mechanism for dealing with these matters is next sketched, and from the preceding argument it clearly has to take the form of a central organisation for all Departments of State. Accordingly it is recommended to set up an Inter-Departmental Patents Board having two main functions, one on the lines of the Royal Commission on Awards to Inventors, for the purpose of dealing with awards, deciding as to the extent of the assistance due to the inventor's position in a Department, and determining the share of the Government in commercial profits, and the other to arrange for the exploitation of patents to the best advantage. The Board itself would fulfil the former function by acting as an Awards Committee, but for the latter, which deals with commercial matters, it would establish an independent Exploitation Committee with its secretary as intermediary.

In order to secure the full confidence of the inventor, it is recommended that the Inter-Departmental Patents Board should be a neutral and impartial body, on which are to be found neither representatives of the Departments concerned nor of the technical workers, but that it should have a permanent chairman of sound legal training and experience, and members characterised by their knowledge of the application of research and invention to industry. As this aspect of the work of the Board is judicial, it is deemed well to keep separate from the commercial aspect, which would be delegated to a committee of a different type—the Exploitation Committee—composed of nominees of the Departments, of the Treasury, and of business men with suitable experience and willing to assist in the exploitation of patents.

The Report proceeds to consider more closely the proposed mode of working of the Inter-Departmental Patents Board, this Board sitting as an Awards Committee, and of the Exploitation Committee. The Inter-Departmental Patents Board would have a permanent Chairman, and a small staff, under the Chairman's direction, would co-ordinate the work of the two Committees. Its cost would be borne by the Treasury, part of whose functions it would have delegated to it; its awards, however, would not be subject to revision by the Treasury on the ground of amount, but only on questions of principle. An inventor would, in the first place, be deemed to hold in trust on behalf of the Government all rights relating to his invention, but would be entitled to obtain from the Board a decision defining his rights, and he would undertake to assign his patent if called upon to do so, or the Board might decide to leave the completion of the patent to the inventor for his sole benefit. All non-secret patents in which the State has an owning interest would be assigned, not as at present to a Secretary of State, or to a Departmental Trust, but to a single organisation. The Board would also consider the case of the Government servant who was not specially engaged on research or development work, but who produced an invention.

The Awards Committee would consider the rights of the inventor in the light of the principles enunciated above. Except only in respect to awards would this Committee or the Board itself deal with secret patents for which the inventor has no possibility of securing commercial rights and the use of which is limited. Decisions as to maintaining their secrecy must remain in the hands of the respective Departments, who, if they desired, could consult in private with the Board. To avoid an undue burden being thrown upon the Inter-Departmental Board, it is provided that the Departmental Awards Committee of any Department should act as a committee of the Main Board and have power to deal with minor cases, forwarding to the Main Board only such cases as appear important as involving principles, or as being likely to result in an award exceeding 1000*l*.

Indications are given in the Report as to the mode of treatment by the Awards Committee of inventions which are a result of work by a team of part-time workers, and by workers aided by grants given for the sole purpose of increasing the bounds of knowledge.

The work of the Exploitation Committee is a matter of peculiar difficulty, seeing that this Committee would have to advise as to the advantage of completing protection by patents and exploiting them commercially when patented, and arrange with their business agents for placing them in the most favourable manner. It is hoped from experience during the War that men engaged in industry and commerce would still be willing to place their services at the disposal of the State for the achievement of these national aims. It would be the duty of this Committee to secure profits from the useful application of the patents under its charge, whether from their sale or from licences for their use. It would have the power of making a final decision, as this is vital in order that business dealings may be brought to an issue quickly and satisfactorily, and would employ sales agents paid on commission. If demonstrations on the semi-industrial scale, or works trials on the large scale, appeared desirable, this Committee would be empowered to carry them out. The

Exploitation Committee would also advise on the taking out of foreign patents, to be sold outright, however, so as to avoid the inconvenience of a Government organisation having to maintain a question of validity in a foreign country.

Some other matters of interest in this Report may be briefly mentioned. Doubt is expressed as to the soundness of the practice obtaining in one Department at least, of stopping short at provisional protection in the case of inventions of value for the preservation of health or of life, or the general use of which could be enforced by a Government Department; completion of the patent is now advised on the ground that very often no commercial use can be made of an invention unless a definite monopoly is granted to a manufacturing firm. Similarly, foreign patents for such inventions should be taken out.

For the encouragement of meritorious research workers, it is recommended in the Report that the head of a department should be given the power to promote successful investigators, or to secure for them special increases of salary, within certain limits, and without promotion out of their grade. The opinion is also recorded that the remuneration of scientific workers should be adequate and that they should have reasonable security of tenure.

While the Committee states it has not found that Government Departments are more reluctant than industrial firms to allow the publication of the results of scientific investigations, it is strongly of opinion that no obstacle should be placed in the way of research workers who wish to publish such results, regard being had to the national interest, and it proceeds to point out that the Government will secure the services of men of scientific ability and reputation, only if such permission is not withheld except under exceptional circumstances.

A mode of procedure is recommended to secure for the worker the opportunity of lodging a provisional application at the Patent Office without submitting it through his superior officer, who would, however, be supplied with a copy from the perusal of which he could decide as to whether the invention should be regarded as secret. Attention is directed to the importance of advertising to all concerned the conditions in force regarding the taking out of patents.

Such are the main features of this important Report. It cannot be denied that there existed an urgent need for a detailed consideration of the whole patent question for which different Departments of State had varying provisions and regulations. The matter is one of peculiar difficulty, on account of the personal association of a worker with the idea which ultimately leads to a successful patented process, while at the same time he is in receipt of maintenance and facilities. In spite of one phrase in this Report where the position of Government servants not specially engaged on experimental work is being discussed, in the words that "it was no part of the bargain made between them and the Government Department concerned when they entered into its employment, that they should make discoveries or inventions," it can safely be said that no such contract of service could reasonably be demanded. By maintaining a well-equipped establishment with adequate facilities and conditions for a well-chosen investigating staff, the employer has a good ground for belief that an atmosphere will be created in which at any time striking new ideas may arise, but he cannot claim to expect more than this in the way of striking developments. It is to this balance of interests that the Committee has applied itself, and in the passage quoted earlier in this notice has defined the position of research worker maintained by the Government, with regard to his claim to ownership in inventions. While laying stress on the general principles that the invention of such a worker is the property of the State, and that the reward to the inventor is contingent on the connexion of the invention with the work for which he was engaged, the Report makes clear that in settling the question all the circumstances of the case will be taken into account, having in mind, no doubt, such matters as the case when a Department desires to keep the invention secret, the merit and importance of the invention, together with any peculiarity in conditions of employment.

The tribunal suggested to adjudicate on such points, in view of its neutral character, should go far towards securing the confidence of the inventor, more especially as he should no longer be able to point to lack of uniformity in treatment by different branches of the Service. From the body of decisions of this tribunal there will, no doubt, gradually emerge sufficiently definite guiding principles to enable new applications to be dealt with expeditiously and fairly.

Much will depend on the interpretation of the principles described above in the first decisions arrived at by the Patents Board, and the extent to which encouragement to the scientific worker, one of the objects laid down in the terms of reference, is to result will be watched with interest.

Up to this point the Report is fairly clear, and there is no reason why its recommendations should not be carried out satisfactorily. It is to be hoped that it will be equally successful in the much more difficult task of exploiting inventions. Although, under the existing system in some Departments, a Government servant may be able to obtain permission to have reassigned to him the non-Governmental rights of an

invention made in the course of his work in order to exploit it commercially, he is rarely in a position adequately to carry this through, either from want of time on account of his normal duties, or from want of business ability. The inventor had the alternative in the event of a process proving an important one either to leave the Government Service and devote himself to his patent, or to remain in the Service and see the success of his invention jeopardised in its civil applications. The exploitation of Government-owned inventions by business men who have had experience in work of this kind is the only other way out of the difficulty that can readily be seen, and it is to be hoped that the confidence of the Committee will be justified by suitable public-spirited men coming forward to take up the work.

The Report bears internal evidence of much thought and consideration of diverse opinions, and thanks are due to members of the Committee for their hopeful effort to suggest an organisation which, by settling claims and disputes definitely and rapidly, will thereby remove an impediment to progress in investigation and at the same time afford the worker the opportunity of stating his case.

Principles and Problems of Aeronautics.

The Mechanical Principles of the Aeroplane. By Dr. S. Brodetsky. Pp. vii + 272. (London: J. and A. Churchill, 1921.) 21*s.* net.

THE entry of Dr. Brodetsky into the ranks of workers on aeronautical topics marks an important development in the higher study of aerial navigation. Why the achievements of modern aviation have not from the outset been built up on a substructure of purely abstract mathematical theory such as has arisen concomitantly with other branches of physics and engineering is difficult to understand. The behaviour of laminæ and other bodies moving through a medium under assumed laws of resistance, whether artificially propelled or otherwise, opens up a vast collection of problems which might well have occupied the attention of mathematicians and been illustrated by experiments with models long before the evolution of the full-sized aeroplane. Instead of this being done, flying machines have been built, flown, wrecked, and their pilots killed, by designers who have not even fully appreciated such elementary facts as that when an aeroplane is moving with uniform velocity the forces acting on it must be in equilibrium, that three forces in equilibrium must meet in a point, that an aeroplane has six degrees of freedom, that stability and equilibrium are not the same thing, and so forth. Whether the Tarrant triplane could have been saved by a full appreciation on the part of its pilots of the validity of the equation of *initial* angular acceleration, $Id^2\theta/dt^2 = M$, or numerous aviators saved from death by a better knowledge of the forces and couples on which longitudinal and lateral stability depend, are debatable questions. Meanwhile mathematicians of repute have attacked the writer of this review for intimating that a fuller theoretical study of the problem should be undertaken.

The National Physical Laboratory and the Royal Aircraft Establishment have absorbed many of the most enlightened of our university graduates who are competent to study aeronautical problems, and they are doing excellent work there. But, unfortunately, the amount of constructional work that had been going on while the mathematicians of our universities were making and marking examination questions, with their eyes shut to the outside world, has thrust on our Government institutions vast arrears of questions arising out of the engineering and physical difficulties associated with aviation. It is therefore not surprising that scarcely any one previous to Dr. Brodetsky has started at the opposite end and tried to fathom the capabilities of pure mathematical reasoning as distinct from experiment in throwing light on the study of aeronautical problems.

A notable exception is afforded by Mr. Lanchester, whose two volumes certainly represent a genuine attempt to investigate the behaviour of aeroplanes as deduced from *a priori* reasoning. But the subject was bristling with mathematical difficulties of a cut-and-dried character quite outside the scope of Lanchester's resources, and no mathematician would take up the challenges so oft repeated in NATURE until Dr. Brodetsky came on the scene. Contrast this state of affairs with the past history of electrical engineering, in which subject mathematical tripos candidates were being worried with solutions of Laplace's equations for infinitely long charged cylinders and conditions for solenoidal and lamellar magnets long before Lord Kelvin presented Peterhouse with its electric light.

In recent years nearly every publisher has decided that there is a demand for an up-to-date book on aeronautics, and has got some one to write one. In all these books the effects of the policy of "putting the cart before the horse" is painfully evident. The mathematics is usually of a very elementary and insufficient character until we are confronted with the invariable chapter headed "Stability, Mathematical Theory." This is usually nothing more or less than a mutilated copy of part of the "Science Monograph" on "Stability in Aviation" by the present writer, accompanied by a misuse of signs and symbols and a total disregard for all the accepted doctrines

regarding elegance of mathematical style and form that are calculated to produce chaos and confusion in the study of stability for years to come.

In presenting students of aeronautics with the first treatise that is thoroughly imbued with the ideals and spirit of the best mathematical school of Cambridge, Dr. Brodetsky is performing for aviation what Clerk Maxwell accomplished in anticipation of modern electrical engineering. In both cases the authors have undoubtedly been striking out on new lines and breaking fresh ground with scanty information to guide them as to choice of subject-matter, method, and order of treatment. The subject has thus opened up an almost illimitable collection of unsolved problems of which Dr. Brodetsky's treatise breathes in nearly every line.

As in electrical text-books, Dr. Brodetsky starts with the simplest problems, but unlike them, appears to avoid their subsequent contradiction of previous results. After a short introduction involving a summary of the problems presented by the heavier-than-air machine, section 1, dealing with "Motion in Air," opens with a chapter on "Dimensions," dealing with elementary dynamical principles, in which account is taken of such possible influences as viscosity. At this early stage important innovations in the matter of notation become necessary. If the object of the writers who are continually changing their axes is to avoid copying the original stability monograph, they would have caused less confusion if they had adopted different letters. Now that L_p may mean M_q or $-N_r$, it has become necessary to scrap the original notation and substitute an entirely different set of symbols. It is to be hoped that the same mistake will not again be made, but that Dr. Brodetsky's notation for the so-called "derivatives" and similar quantities will be accepted as a permanent solution for the present chaos. It certainly represents the best that could be evolved after many hours of consideration, in which the present reviewer took part when studying with Dr. Brodetsky through a grant from the Research Department under the hospitable roof of Bristol University.

The next chapter deals with problems on resisted motion falling within the range of particle dynamics, including a study of Lanchester's phugoid curves. The reference to "catastrophic instability" on p. 53 is important in view of the frequent Press notices of aeroplanes which are stated to have turned over suddenly and crashed to the ground.

Two-dimensional rigid dynamics forms the subject of the next chapter, which embraces not only the ordinary theory of longitudinal stability (including a *rigorous* proof of Routh's discriminant condition), but also applications to the kite and parachute. Further, there is an original investigation of the motion under gravity of a lamina under an assumed simplified law of resistance which is illustrated by diagrams deduced from theory and compared with experiment. The reference to periodic solutions should receive serious consideration. It must not be forgotten that an aeroplane may be stable for small deviations from steady motion and may yet be capable under suitable initial conditions of acquiring a periodic motion turning over and over in loops until it crashes to the ground, while it may be impracticable to extricate it from this state. The aeroplane which effected a successful landing after its observer and pilot had been shot dead did not necessarily possess immunity from this danger, which might have occurred if the machine had started under different initial conditions.

The next chapter deals with applications of three-dimensional rigid dynamics. Here the range of solved problems is necessarily limited. It, however, includes circular and spiral flights and lateral stability of the aeroplane, the parachute and the kite. In these sections Dr. Brodetsky's notation is a great improvement on its predecessors. It has the great advantage that, like the notation in the original treatment of stability, it makes the terms of the biquadratic all positive. In the same way it is much easier to write down the pressure equation in hydrodynamics with the old-fashioned velocity potential instead of the new one.

As regards section 2 ("Dynamics of Air") there is less to be said. The one direction in which mathematicians have made a serious attempt to do substantial work more or less connected with aeronautics (often less) has been in applying hydrodynamics — mainly two-dimensional hydrodynamics of perfect incompressible fluids—to the study of pressures on moving laminæ. In this connection Dr. Brodetsky gives a good general treatment of discontinuous motion. The book as a whole, however, is calculated to emphasise the importance of rigid dynamics as applied to aircraft in their entirety in contrast to these popular hydrodynamical investigations of flow of air round parts of their structure, which, as a matter of fact, are largely affected by mutual interference. It is to wind channel experiments that we must look for the determination of the quantities required in theoretical developments.

In section 3 Dr. Brodetsky returns to the original methods of treatment, and we are glad to notice his recognition of the concept of the ideal "narrow planes gliding at small angles" as having made it possible to initiate a formal study of stability in anticipation of the modern wind tumult. In the

next sections he gives a theory of the propeller, while chap. 8 deals with the problem of the aeroplane in moving air. Following Prof. E. B. Wilson the treatment is based on the study of forced oscillations, but the reader will do well to follow Dr. Brodetsky's advice and read his alternative treatment by the method of initial motions. This latter method, by the way, opens up an almost unlimited supply of calculable problems which cannot fail to throw light on questions regarding design and control of aircraft which are under the direction of their pilots.[1]

A further important innovation is the insertion of collections of exercises, commonly described as "Examples." Here again Dr. Brodetsky has had the difficult task of striking out in a new line in incorporating the features of a Cambridge text-book in an aeronautical treatise. This feature will, we hope, be of great use in making the present important developments of applied mathematics available in our honours schools.

A further contribution to the study of aeroplane mathematics by Dr. Brodetsky appeared in the *Mathematical Gazette* for May 1921. It dealt mainly with the conditions of equilibrium of the forces acting on an aeroplane in steady motion of different types, such as horizontal flight, climbing, descending, gliding with or without varying the elevator, diving and upside-down flight, load variations, variation of air density with altitude, flight in steady wind, and circling and helical flights with and without sideslip. In conclusion Dr. Brodetsky remarked: "The present paper will perhaps suffice as an indication to teachers of mathematics and others of how much really useful and interesting information can be obtained with easy mathematics. The introduction of aeroplane mathematics into ordinary courses in all our schools and universities would be a great boon to teachers as well as to pupils."

In addition to strongly supporting Dr. Brodetsky's plea for the study of aeroplane problems by mathematicians and their pupils, we would refer to the equally important task which remains, of equipping the workers in the aeroplane industry with a better knowledge of the principles of mechanics involved in aircraft construction and manipulation. In this connection it is to be hoped that the Institute of Aeronautical Engineers, now two years old, will prove a valuable addition to the roll of similar technical and professional institutes that have been formed in nearly every other branch of applied science, the ranks of which are largely recruited from the students of our technical colleges and universities. For such students Dr. Brodetsky's book is specially suitable.

G. H. BRYAN.

[1] The investigations which the writer of this review was able to initiate and undertake with the assistance of a three-years grant from the Research Department could not for various reasons be incorporated in Dr. Brodetsky's treatise, but have been published in the Reports and Memoranda of the Advisory Committee for Aeronautics and the Aeronautical Research Committee, Nos. 555, 640, 684, 689, and 744, the last two dealing with the general equations of motion of aeroplanes studied from several novel points of view with the use of Brodetsky's notation. The last Report constitutes a brief exposition of the general theory of initial motions in its application to aeroplanes.

The History of Whaling.

A History of the Whale Fisheries: From the Basque Fisheries of the Tenth Century to the Hunting of the Finner Whale at the Present Date. By Dr. J. T. Jenkins. Pp. 336. (London: H. F. and G. Witherby, 1921.) 18*s*.

AT the close of the last century whaling appeared likely to terminate at an early date, in view of the great reduction in the numbers of whales which had been brought about by a relentless and long-continued persecution. The rate of destruction had been accelerated by the introduction of modern methods, and if new fields had not been discovered whaling might by now be almost a thing of the past. Dr. Jenkins's book contains a large amount of information which will be of great value to those who wish to satisfy themselves whether the lessons of history confirm the forebodings which have been expressed about the future of whales.

The work opens with an account of whales, their species, habits and migrations, and zoologists may turn with interest to an Icelandic classification (p. 87) of 1777, which within its limits is not inferior to the most modern system, or to the excellent account of the Greenland whale (p. 116) given by Edge, who took part in Arctic whaling in 1610. The next chapter deals with the products of whales, the method of hunting, and whaling legislation, giving also a brief review of the successive phases of the industry, a subject which is considered in greater detail in later chapters. Whale-oil, a material which was formerly indispensable for the lighting of houses, public buildings, and streets, has remained one of the most important raw materials for the manufacture of soap and glycerine, the great quantities of glycerine which were extracted from it during the war having been of vital importance to this country. Spermaceti, ambergris, and whalebone are still highly valued materials, while the greater part of the carcasses of whales is utilised in the preparation of agricultural manure, the flesh being partly converted into cattle-foods or even used for human consumption.

The first known account of whaling is that of Ochther, who voyaged beyond the North Cape towards the end of the ninth century, and afterwards described

his journey to King Alfred (p. 59). The whale industry of the Bay of Biscay, depending principally on the Atlantic right whale, can also be traced back to an early date, since it was at its apogee in the twelfth and thirteenth centuries (p. 61). The Basques appear to have voyaged to Newfoundland as early as 1372 (p. 64), thus anticipating Columbus by more than a century. It will perhaps surprise the general reader to learn that train oil, a name derived from the Dutch *traan*, a tear or drop, is mentioned as a material "to the great commodity and benefit of this our Realm of England," in a grant by Queen Elizabeth, 1576–7 (p. 303).

For nearly three centuries the Greenland whale occupied a position of special importance in the industry, at first in the neighbourhood of Spitsbergen (from about 1604), later in Davis Straits (from 1718), and in the North Pacific and the Arctic Ocean beyond Bering Straits still later (from 1846). The sperm whale industry had meanwhile become so important as to rival that based on the Greenland whale, starting off New England about 1614 (p. 223), and afterwards extending into the Atlantic, Pacific, and Indian Oceans. The Pacific grey whale was hunted for a relatively short period off the coast of California, an original method of capture having previously been invented by the Indians. The operations off Iceland, Newfoundland, Japan, the British coasts (on a larger scale than is generally recognised), and Spain are described in the concluding chapter, which also deals with the specially important modern development of whaling, carried on since 1905 in the neighbourhood of the Antarctic continent, as well as off the coasts of South Africa and South America. This subject, of urgent public interest, deserved fuller treatment.

Dr. Jenkins does not sufficiently emphasise in his work the deplorable reduction in the number of humpbacks within five or six years from the commencement of operations off South Georgia, and he seems to regard this species as still very common off the South African coasts (pp. 295, 296). In suggesting a winter Antarctic close season (p. 299) he is not up to date, as this measure has recently been authorised by the Colonial Office, while the list of the chief existing southern whaling areas on p. 292 gives no hint of the predominance of South Georgia and the South Shetlands, nor does it indicate that whaling operations in the South Orkneys, Australia, Kerguelen, and other localities are extinct or of negligible importance. It would scarcely be inferred from the account of the African stations how great has been the shrinkage of the industry within the last decade. The impoverishment of the natural resources of the world due to the operations of the whalers, and obvious from their own records, might have been explained with greater emphasis. The statement (p. 234) that the discovery of petroleum in 1859 sealed the fate of American whaling can scarcely be described as the only cause, for the diminution in the number of whales which was taking place must have had some influence in producing this result.

It is melancholy to compare the existing distribution of whales with their former abundance. The Greenland whale occurred in profusion in the bays of Spitsbergen at the commencement of Arctic whaling, and the Varanger Fjord during March "simply bubbles or boils" with humpbacks (p. 32). Atlantic right whales regularly passed Biarritz towards the end of the seventeenth century (p. 64), while whales were plentiful off New England in 1614, where an early writer speaks of "mighty whales spewing up water in the air like the smoke of a chimney, of such incredible bigness that I will never wonder that the body of Jonah could be in the belly of a whale" (p. 223). These occurrences are now mostly things of the past and though Dr. Jenkins fully recognises the fact, he is perhaps not sufficiently convinced of the danger of extinction.

The production of whale-oil is usually estimated in barrels, and some discussion of the capacity of this measure would have been useful. The book must be read carefully to discover a reference (p. 244) to barrels of thirty gallons each and a statement (p. 293) that the standard size is now six barrels of oil to one ton. On p. 294 the question is unnecessarily complicated by giving the oil production for Natal in pounds for 1909, in barrels and tons for 1910, and in pounds for British South Africa, 1910. Scoresby (1820) had already stated that the ton consisted of 252 gallons, and had given experimental estimations of the number of pounds of oil to the gallon at different temperatures; from his remarks, however, on the gauging of casks and from his list of stores, where he says that the casks should be of sizes suitable for stowage, it is obvious that the barrel was not a definite measure. There is probably considerable uncertainty as to the extent of a catch estimated as so many barrels of oil.

The figures given by Dr. Jenkins occasionally arouse doubts as to their accuracy, as on p. 268, from which it would appear that, after deducting the value of the baleen, a blue whale is worth 90*l.* and the smaller fin whale 110*l.* In other cases sufficient care has not been taken to explain that a statement is no longer correct, as in the account (p. 29) of the Pacific grey whale, which has ceased to be common on the coast of California. Exception may also be taken to p. 265, representing the facilitation of the capture of the *smaller* whales as the principal result of the introduction of Svend Foyn's harpoon-gun. The statement (p. 293) that whalebone is worth from 39*l.* to 45*l.* a ton is

ambiguous, since the list to which it refers includes not only the Rorquals, but also the Greenland whale. It appears from another page that the whalebone of the Greenland whale fetched 1250*l.* a ton in 1901, and even this falls far short of the highest price it is known to have reached.

Some points might have been brought out more clearly by relegating details to tables in which one year could easily have been compared with another. By setting these facts out at length in his main narrative the author has failed, to some extent, to give a correct perspective of the general trend of events. There can be no doubt that whales have diminished in number, and Dr. Jenkins's book will do real service if, by calling attention to the history of the past, it awakens interest in the urgent necessity of so regulating the industry as to avoid the disaster of completing the destruction of animals which must rank as among the most wonderful of mammals. The book contains much information extracted from State papers and other old records at home and abroad, special attention having been given to the Dutch whaling literature. Many of these documents are so inaccessible that the gratitude of zoologists is due to Dr. Jenkins for this service.

Inorganic Chemistry as a Science.

Handbuch der anorganischen Chemie in vier Bänden Edited by Prof. R. Abegg and Dr. Fr. Auerbach. Vierter Band. *Erste Abteilung, zweite Hälfte. Die Elemente der sechsten Gruppe des periodischen Systems. Zweite Hälfte.* Edited by Dr. Fr. Auerbach. Pp. xiii+1072. (Leipzig: S. Hirzel, 1921.) 140 marks.

ALL chemists will rejoice at the appearance of another volume of the well-known Abegg-Auerbach "Handbook of Inorganic Chemistry," and we desire to offer Dr. Fr. Auerbach our hearty congratulations on his success in carrying on so worthily the great work begun by Abegg. The last volume, dealing with F, Cl, Br, I, and Mn, appeared in 1913. As the editor states in the preface, the appearance of the present volume has been delayed by the European war. It deals with the elements Cr, Mo, W, and U, which belong to the sixth group of the periodic table. It is intended that O, S, Se, and Te shall be dealt with in a later volume.

The authorship of the monographs contained in the present volume is as follows: Chromium, Molybdenum, and Tungsten, J. Koppel; Uranium, R. J. Meyer; Hetero-poly-acids, A. Rosenheim.

The famous writer of the articles on atomic weights in the previous volumes—Brauner—has now dropped out and his place is taken by J. Meyer. Similarly we miss the name of Lottermoser in connection with the articles dealing with colloid chemistry, these being now written by G. Jander.

A very important part of the volume under review is the extensive monograph by Rosenheim on the hetero-poly-acids and their salts. Although the corresponding complex anions may be derived from elements other than those dealt with in this volume, these compounds have been treated as a single group and included in the present volume, since molybdenum and tungsten are amongst the constituents which occur most frequently in these anionic complexes. This is a happy idea and a most useful one, for the monograph by Rosenheim is probably the first really comprehensive and satisfactory survey of this difficult subject that has appeared.

Of the 1064 pages (omitting the subject index) in the present volume, 465 are occupied by the article on chromium. This is undoubtedly one of the finest chemical monographs ever written and must have cost the author an immense amount of thought, labour, and time. We all owe him a great debt of thanks for his splendid work. Attention may be directed specially to his exhaustive treatment of the complex chromi-ammines (which alone occupies eighty-two pages), the anionic chromi-complexes, the passivity and "electromotive" behaviour of chromium, and the heterogeneous equilibria in which chromium compounds are involved.

Under tungsten there is an excellent account of the tungsten filament lamp and the methods of preparing and treating metallic tungsten, while the monograph on uranium and its compounds by R. J. Meyer contains a very good account of the physical chemistry of the uranyl compounds.

But where everything is so good, it is difficult to select any special part for particular mention. Thus the articles on atomic weights and on colloid chemistry by J. Meyer and G. Jander respectively appear to be quite up to the high standard set in previous volumes. We can give the present volume no higher praise than to say that it would have rejoiced the heart of Abegg. Of the great "Handbook" it can still be said that it must be in the possession of, or readily accessible to, every scientific chemist, whatever may be his special occupation or province of work. It constitutes a re-writing of inorganic chemistry on the basis of the pioneer work of Mendeléeff, Gibbs, Rooseboom, Thomsen, Arrhenius, van't Hoff, Ostwald, Nernst, Abegg, Bodländer and Werner. It does for the present generation what the great work of Gmelin did for a previous one. It utilises thermodynamics and the theory of ions in carrying inorganic chemistry another

stage forward on its journey towards the ever-unattainable goal of perfect knowledge. It is still the history of the individual written from the behaviour of the crowd. Some day another Abegg will tell the story of the next stage, perhaps the history of the crowd written from the behaviour of the individual. However that may be, we chemists of the present generation cannot be too grateful to Abegg for the work which he did in bringing inorganic chemistry abreast of the progress of chemical science.

F. G. DONNAN.

Cloud-Forms.

Le Nubi. By L. Taffara. Parte 1, Testo. Pp. 67. Parte 2, Atlante. Tav. 26. (R. Ufficio Centrale di Meteorologia e Geodinamica Roma.) (Roma: Tipografia Ditta L. Cecchini, 1917.)

THE recent revival of interest in cloud-forms which has expressed itself in the publication of various collections of photographs is well illustrated by the atlas which was prepared by Signor L. Taffara and issued in 1917 by the Meteorological Institute of Rome, together with an introductory text which is reprinted from vol. 37 of the Annali of the institute.

The text leads up to a chapter on procedure in the observation of the height and motion of clouds. On the way it explains the history of the study of clouds on the basis of international agreement, the original specification of ten cloud types, the international atlas of 1895, the revision at the International Conference at Innsbruck in 1905 and the republication of the atlas in 1910, which included the ten types and nine variants with a special note on clouds of a type called "lenticularis," the importance of which becomes increasingly evident. In the meantime (1907) the late M. Vincent, of the observatory at Uccle, Brussels, had published an atlas of cloud-forms with much more elaborate classification, which had been followed by Dr. Loisel, of the observatory of Juvisy (Paris), in 1911. The suggested classification includes nine species, comprising twenty-one varieties of lower cloud; two species, twelve varieties of middle cloud (which may further require one of the adjectives "undulatus," "striatus," or "mammatus"); and four species, nineteen varieties of high cloud, which may require further discrimination as "undulatus," altogether fifty-two forms of cloud to be discriminated, or upwards of one hundred if discrimination by adjectives is included. Of the many additional variants that are thus introduced, two—namely, pallio-nimbus, which seems to be a good formula for a rainy day, and alto-cumulus castellatus, a sign of approaching thunder—seem to have acquired merit. Signor Taffara accepts this classification as being the most complete, and in his atlas gives forty-nine photographs (including three autochromes), most of them by himself, but some by Mascari, Loisel, Gamba, Ponte, Peret, Neuhaus, a pastel by Scalla, and two water-colour drawings, which illustrate thirty-six of the hundred examples, and one more type in addition, which is defined as "lenticularis." It does not occur in the list quoted from Vincent. The reproduction of the photographs is excellent; the art of photography of clouds is the subject of a special chapter of the text. The collection forms a beautiful book.

Among the pictures are two very definite types of cloud which belong to the region of Mount Etna and are admirably represented by reproductions of Signor A. Marcari's photographs; these are "la serpe," a long serpentine cloud shown straggling along like a snake, low on the mountain; and "Contessa del vento," a stationary cloud of the Valle del Bove, of which no fewer than five examples are given. These clouds are disposed of in the classification as being "cumulus humilis," in association with other cumulus of low level; but the obviously lenticular nature of the "Contessa del vento" marks it out as being something entirely different from any of the hundred forms. It looks like a gigantic white turban, the crown of which merges into other clouds, and it suggests the core of an eddy, possibly formed mechanically by the mountain, since all lenticular clouds seem to be associated with peculiar dynamical conditions due to the unevenness of the surface. If the lenticular shape indicates the locus of formation of cloud in wind that blows through the cloud, not with it, as it appears to do in other cases, we have apparently in these clouds an opportunity for studying the conditions at close quarters.

We are scarcely yet in a position to make a final classification of clouds, and the elaborate classification into some hundred forms is somewhat premature. Presumably we should begin by drawing a distinction between individual clouds and cloud-groups. Cumulus is a cloud, alto-cumulus a cloud-group. It is questionable whether a vast layer which discloses small cumulus on its margins is fairly classified by the appearance of the cloudlets there. We have no sufficient principles of classification, and for that reason a multitude of discriminatory characteristics scarcely helps us at this stage. The contribution to our knowledge of different forms which the Ufficio Reale has made through the agency of Prof. Taffara is a valuable addition to the material from which classification will at some time emerge. It seems

desirable that the path should not be encumbered beforehand with too many adjectives, though it may be confessed that Latin adjectives have a peculiar fascination. They trip so lightly off the tongue that when one begins to use them one scarcely knows where to stop.

Napier Shaw.

Prehistoric Western Europe.

(1) *The New Stone Age in Northern Europe.* By Prof. J. M. Tyler. Pp. xviii+310. (London: G. Bell and Sons, Ltd., 1921.) 15*s*. net.

(2) *Man and His Past.* By O. G. S. Crawford. Pp. xv+227. (London: Oxford University Press, 1921.) 10*s*. 6*d*. net.

We gladly extend a welcome to these two books as real signs of a publishing revival as well as of the widespread interest in the far past due to the diffusion of the idea that, when some day we find the right clues, prehistoric Western Europe will become almost as fascinating as the prehistoric Ægean has become through the great advances of knowledge in the last generation. Both writers have in view the general public, but their aims are very different. Prof. Tyler has striven to interpret the results of research up to about 1912 so as to give the reader a fairly connected story, but in spite of cautious reserve, here and there he unfortunately obscures many difficulties, and suggests that knowledge exists where the careful worker knows only the depths of ignorance. Mr. Crawford, like Prof. Tyler, has also an annoying habit of discursive remarks on things in general, and these irrelevancies make his book larger than it need have been; but his valuable purpose is evidently to stimulate the local archæologist and to enlighten him as to methods in those provinces of study which he can legitimately occupy.

It is a sign of progress that both books look back to Déchelette, the acceptance of whose work now marks any book that claims serious attention, at any rate if it deals with Palæolithic times. But Prof. Tyler carries over a great deal from far older and less trustworthy sources into the new period and gives us a most dangerous sketch of the coming of the "Indo-Aryans," that name of ill omen in archæology. Moreover, he has not taken Déchelette's maps to heart, and needs to learn the lesson Mr. Crawford sets out to teach, namely, that finds and prehistoric remains of all kinds need to be mapped accurately for serious geographical study. Mr. Crawford will not think it amiss if we say that among his papers (*e.g. Geog. Journ.*, 1912) are many things that teach the lesson more effectively than this present book. None the less, precept does come with a certain appropriateness from a well-known practician, and Mr. Crawford's suggestions about road tracing imply that he is going to develop the archæological data on our ordnance maps in his new and appropriate position as Archæologist to the Ordnance Survey.

(1) After reading Prof. Tyler's book, one is more than ever convinced of the need for a careful resurvey of all the evidence for the periods that are commonly supposed to intervene between the Magdalenian and the beginning of the Bronze age. Some megaliths almost certainly belong to the Bronze age even if bronze finds do not occur in them, and some of the finds of polished stone axes, and so on, are in danger of being shown to belong to the Metal ages. On the other hand, some finds of flints of Azilian and perhaps earlier types are likely to be shown also to belong to later dates and even to the Iron age. In other words, survivals of late Palæolithic cultures seem to have lingered on into the Metal ages in N.W. Europe, and metal seems to have come in gradually, locally, and partially, so that the so-called Neolithic period, while still acknowledged to be real enough, is seeing both its limits fade away. Prof. Tyler is perhaps justified in neglecting these refinements, but a more definite consciousness of them, as well as a study of the files of the Journal of the Royal Anthropological Institute, especially for Mr. H. J. Peake's papers, would have helped him over many a stile.

Perhaps his chapter on Megaliths is the most inadequate in a book that must be considered, broadly, a failure, in spite of several points which are at any rate suggestive. Take, for example, the contrasts in distribution between so-called dolmens and *allées couvertes*, and the similarities between the spread of the latter and that of menhirs. The peculiar localisation of holed dolmens, the relation of the *allée couverte* to the English long barrow and the Scottish long cairn, whether holed or not, as well as to the *Ganggräber* of North Germany, are all points for serious study by the next person who tries to make a prehistoric synthesis. The views of Perry and others about the relation of dolmen building to metal seeking—prospecting for gold, copper, and tin—should have been studied critically; while Abercromby's "Bronze Age Pottery," with its discussion of the beaker, should have been brought into relation with the loess zone. With such study, a much more vital view of line of movement round about the end of the Neolithic age would have been gained. We greatly need a synthetic statement of the diverse movements of that transition time heralding the opening of the Bronze age with its concentration of attention on the gold of Ireland and so on the ways of getting to it. The succession of shell mound and dolmen (*allée*

couverte) on the same site, as in Guernsey, is another fruitful line of thought, and no synthesis should neglect M. de Guérin's amplifications of Déchelette's views on ancient incised figures and idols.

The movements outlined above must be taken into account by linguists who wish to find a link with archæology, and it will probably be through the forging of that link that the great advance we look for will occur. It is possible to argue for the spread of at least some elements of the languages of the older philologists along the lines of distribution of beaker pottery, but it is quite likely that those language elements travelled far later, with other archæological correlatives, along the line determined in large measure by the presence of loess and the consequent weakness of forest and swamp. One may venture the statement that probably rather by such study than by the more exclusively philological ones suggested by Prof. Tyler will our knowledge of the sources of the European languages be improved, and our views as to their adoption, with modification, by peoples who were not bred with them, made precise. Anyhow, it seems more than likely that our great families of European languages in several cases illustrate adoption of a language-basis from foreigners rather than differentiation of languages by process of time from a single common ancestor. The references to early religion that Prof. Tyler gives seem specially dangerous in the dim light of present-day doubt.

(2) Mr. Crawford's book shows he has been trying to set his thoughts in order after the trials and difficulties of war service, and, in the midst of discursive generalities, one does frequently come upon points of value for the student who wants to take his archæology regionally and to see man at each period in his proper relation to the local environment of that period. Fortunately, Mr. Crawford is alive to the fact that the environment changes with the period even after the close of the Ice age. He sees that the clearing of forests and the draining of swamps have made vast differences to men's opportunities for movement and lines of communication, and he understands the difficulties of argument on these complex problems. He is an impassioned eulogist of old roads and of the joys of tracing them, and the beginner in prehistory who is anxious to get hold of method, rather than of fact, will find Mr. Crawford's book interesting and profitable, though he may be left wondering why the author did not omit a good deal of general talk and give the student a great deal more help along his way.

H. J. F.

Rosenbusch's Petrology.

Mikroskopische Physiographie der petrographisch-wichtigen Mineralien. By H. Rosenbusch. Band 1. Erste Hälfte. *Untersuchungsmethoden.* Fünfte, völlig umgestaltete, Auflage. By Prof. E. A. Wülfing. Lieferung 1. Pp. xvi+252. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nägele), 1921.) 16*s*.

ALL who are interested in petrological studies will welcome a new edition of this familiar text-book, which made its first appearance nearly forty years ago. Every subsequent edition has exceeded its predecessor in size and completeness, and the fifth, to judge from this instalment of the first half of the first volume, is not likely to prove an exception. It is true that some of the topics dealt with in earlier editions, such as the principles of stereographic projection, are omitted as being now sufficiently familiar to the student, but the space thus saved, and more, is required for the developments during the seventeen years that have elapsed since the previous edition was published.

This issue is the work of Prof. E. A. Wülfing, the author of the admirable account of the methods employed in the microscopical examination of minerals in the fourth edition of the book, and the successor of Rosenbusch at Heidelberg. It has been to a large extent rewritten, and there is a decided advance in the clearness with which the fundamental principles are explained, even if the mathematical aspect of the subject is perhaps still somewhat over-emphasised in places.

The first forty pages are mainly devoted to a detailed description of the most up-to-date methods of cutting, grinding, and mounting thin slices of rocks. This is followed by an exposition of the author's views on the nature of light and an account of its properties in both isotropic and anisotropic media, including the phenomena of absorption and pleochroism. There is also a useful section devoted to the methods of producing polarised light in which the different forms of prism that have been devised for the purpose are described, and another to the production of monochromatic light.

The text is accompanied by numerous clearly drawn illustrations, many of which appear for the first time, and there is a handsome coloured plate giving the succession of Newton's colours, the amount of relative retardation corresponding to the different tints, and the usual graphic representation of the relation between birefringence, thickness, and relative retardation.

JOHN W. EVANS.

Our Bookshelf.

An Agricultural Atlas of Wales. Made on behalf of the Institute for Research in Agricultural Economics, University of Oxford, by J. Pryse Howell. Pp. iii + 23 maps + 3 maps in pocket. (Southampton: Ordnance Survey, 1921.) 5s. net.

IT is to be hoped that the enterprise of the Ordnance Survey in publishing an agricultural atlas of Wales will be rewarded sufficiently to facilitate the publication of similar atlases for regions of England. Mr. J. Pryse Howell has worked at agricultural surveys for years at Aberystwyth and at Oxford, and the present atlas does considerable credit to his care and industry. It is based on parochial returns, and consists of twenty-three maps, one for each agricultural product. There are also three loose maps in colour giving the orography, geology, and rainfall of Wales, and as the agricultural maps are on translucent paper they can be superimposed on the loose maps in order to trace correlations.

It is a pity that the revision of Welsh geology is not yet sufficiently complete to give a better representation of the stratigraphy of West Wales based on the work of Prof. O. T. Jones and the correlation with geological facts. The correlations traceable often depend more on the drift than on the solid geology, though these maps of Wales are mostly of a kind simpler than one would find in England, for in Wales the greater part of the surface is impervious soil on hard rocks, and agriculture is dominated by orographical conditions which so greatly influence rainfall. In England the influence of soil would be more complex.

The agricultural relations of the belt between the Vale of Clwyd and the Dee at Corwen, of the lower Montgomeryshire Severn, the parallels between pigs and potatoes, and many other points, stand out clearly, while the curious distribution of lucerne, sainfoin, clover, and grasses under rotation prompts a number of questions. The atlas should be used widely by agriculturists and economists, by persons interested in local administration, and by teachers, especially teachers of geography.

The Silver Bromide Grain of Photographic Emulsions. By A. P. H. Trivelli and S. E. Sheppard. (Monographs on the Theory of Photography from the Research Laboratory of the Eastman Kodak Co.) Pp. 143. (New York: D. Van Nostrand Co.; London: Kodak, Ltd., 1921.) 15s.

THE research laboratory of the Eastman Kodak Co. has in preparation a series of monographs on the theory of photography. The time is ripe for the presentation in a connected sequence of the work done and the results obtained, for these are very numerous and very scattered. The present volume is the first issued, and presumably may be regarded as a sample of those that are to follow. The company, the laboratory, and the authors are to be congratulated in that they have made so good a beginning. The authors have been engaged for some years in the practical study of the subject with which they deal, and they give some results that have not been published before. A study of the relations that exist between the sizes of the grains and their photographic properties is reserved for a future monograph, though it is by no means neglected in the present treatise. The first half of the volume deals with the influence of ammonia on photographic emulsions and a theory of ripening; von Weimarn's theory and the determination of the dispersity of silver bromide precipitates; accessory factors influencing the dispersity of silver bromide emulsions; crystallisation catalysis; and capillarity and crystalline growth. The intimate relation between grain structure and photographic properties is, however, fundamentally a matter of crystallographic investigation, and the remainder of the volume is devoted to this matter in five chapters. The authors state that "when the experimental conditions regulating the three primary factors, (1) dispersity-distribution, (2) recrystallisation, and (3) sorption (both adsorption and desorption), are completely known, scientific control of the characteristic curve—*i.e.* of speed, latitude, and density—will be possible." The book is copiously illustrated and well indexed; it has many summaries, all necessary references, and an extensive bibliography. C. J.

Indian Science Congress: Handbook for the Use of Members attending the Ninth Meeting to be held at Madras from the Thirtieth of January to the Fourth of February, 1922. Pp. x + 165. (Madras: Capt. Clive Newcomb, Chemical Examiner, 1921.)

THE Indian Science Congress has held annual meetings in various parts of India yearly since 1914 much on the lines of the British Association for the Advancement of Science, and the handbook issued for this year's meetings contains a number of interesting articles by experts, including a brief history of Madras and its Corporation, descriptions of the museum and Connemara Public Library, the Madras Harbour, the new city waterworks and the chlorination purification of the supply, and an interesting account of places of historical interest within twenty miles of the city. General education in Madras is dealt with by the principal of the Presidency College, and medical education by the principal of the Medical College. The remainder of the little book is occupied with accounts of scientific work in the Presidency in different branches of knowledge, and includes the work of the King Institute of Preventive Medicine, situated several miles from the city and concerned chiefly with hygiene, and an interesting account of the valuable practical investigations being carried out at the Agricultural and Research Institute at Coimbatore by the Director of Agriculture. Contributions on prehistoric archæology, the anthropology of Southern India, marine zoology, the geology of Madras, and biological work there, complete an instructive handbook which is very suitable for the purpose for which it has been designed. L. R.

Treatise on Fractures in General, Industrial, and Military Practice. By Prof. J. B. Roberts and Dr. J. A. Kelly. Second edition, revised and entirely reset. Pp. x + 755. (Philadelphia and London: J. B. Lippincott Co., 1921.) 42s. net.

THE authors of this volume have set out, as they claim in their preface, to present a lucid view of the subject

in the light of recent discoveries, to point out an accurate scientific procedure, whether operative or other, according to the character of individual injuries, and to urge the general practitioner, as well as the surgical specialist, to the study of methods which, as experience indicates, have given the best results.

As a consequence of experience gained during the war, the treatment of gunshot and other wounds of bones has been revolutionised, because the distinction between aseptic fractures with unbroken skin and those breakages of bone which have been exposed to infection has been fully grasped. The authors insist that much of the old teaching as regards the treatment of fractures still holds good, as, for example, Lucas-Championnière's dogma as to early mobilisation and gentle massage being valuable for restoring contour and function in fractures of shafts and joint-ends of bones. They urge the critical, intelligent, and frequent examination of fractures instead of a too absolute reliance on radiographic interpretations by inexperienced laboratory workers. The illustrations so very necessary in a descriptive book of this nature are, without exception, excellent, and will be found a great help in following the text. Indeed, it is the most complete and comprehensive book on a very important branch of surgery that we have yet seen and it may be regarded as one of the few good results of the world-war.

The Raw Materials of Perfumery: Their Nature, Occurrence and Employment. By E. J. Parry. (Pitman's Common Commodities and Industries.) Pp. ix + 112. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) 3*s*. net.

DURING the last half-century perfumery has in part become a branch of synthetic organic chemistry. Many of the odoriferous constituents of natural perfumes (*e.g.* vanillin and heliotropine) are prepared synthetically in a pure state, and some substitutes (*e.g.* "artificial musk," trinitrobutyl xylene) for natural perfumes are now in use. The rare natural perfumes such as musk have not yet been produced in the test-tube. With the production of the materials, however, the perfumer's art has made only a beginning and much depends on the skilful blending of the constituents. Mr. Parry has given a simple and interesting account of his subject. It is non-technical, and perhaps might have included a little more of the chemistry involved. The latter is of so complicated a character that it would perhaps not have been intelligible to the ordinary reader. The address of the president of the Chemical Section of the British Association last year (NATURE, October 20, 1921, p. 243) shows, however, that something can be done in this direction.

Handbuch der biologischen Arbeitsmethoden. Edited by Prof. Dr. Emil Abderhalden. Leiferung 45, Abt. 5, *Methoden zum Studium der Funktionen der einzelnen Organe der tierischen Organismus.* Teil 7, Heft 2, *Sinnesorgane.* Pp. 197-260. (Berlin und Wien: Urban und Schwarzenberg, 1921.) 28.80 marks.

THE section on the analysis of sounds in Prof. Abderhalden's extensive "Handbuch" is written by Dr. E. Budde. It contains accounts of the use of mechanical integrators for the analysis of a periodic curve, and of the method of calculating the terms of the Fourier series from ordinates at regular distances apart. Tables are given to facilitate the calculation when seventy-two ordinates are measured per period. It is not often that so many ordinates are taken, but when it is necessary or desirable the tables will save much time and trouble.

A Course of Practical Organic Chemistry. By Dr. T. Slater Price and Dr. D. F. Twiss. Third edition. Pp. xiv + 239. (London: Longmans, Green and Co., 1922.) 6*s*. 6*d*.

IN this edition minor alterations have been made to bring the subject-matter up to date. The methods of preparation of typical organic compounds and the quantitative analysis of compounds of carbon, hydrogen, nitrogen, the halogens, sulphur, and phosphorus, are well described. The scheme given for the identification of "an organic compound" is too incomplete to satisfy ordinary requirements, and could usefully be extended in future editions. Mixtures should also be considered.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Langley Machine and the Hammondsport Trials.

THE leading articles in NATURE of November 3 and January 26 last appear to have missed the point of my discourse on the Langley Machine and the Hammondsport Trials. My paper was written to expose a fallacy in which officials of the Smithsonian Institution had used their great opportunities for imposing upon the public a false belief that the Langley machine had been flown in 1914.

The leading articles in NATURE, instead of making any denial of the charge that vital changes were made in the Langley machine at Hammondsport before any flight was attempted, contend that my "paper tends to give an erroneous impression of the importance of the part played by the Wright Brothers" in the producing of the first man-carrying aeroplane. NATURE suggests that it was Langley who did the laborious work of preparing the scientific data upon which the first aeroplane design was based, and that the Wright Brothers merely contributed the system of wing warping—the final step or "keystone"—in the problem of flight. The writer of the articles in NATURE refers to Sir Richard Gregory's book "Discovery," from which he makes two quotations.

I agree with the author of "Discovery" that many great inventions are based upon pure science, and that often the person who receives the credit for an invention is the one who has added some mechanism which turns the scientific knowledge of another to practical use. In the facts in regard to the invention of the aeroplane, however, the author of "Discovery" and the writer of the leading articles in NATURE are in error. The real truth of the discovery of flight is that the Wright Brothers first established a scientific basis for aeroplane design; they then invented the mechanical means for putting this scientific knowledge to practical use. The spectacular nature of the latter has blinded the public to the importance of the former.

In 1914, when I was beginning the preparation of my paper on the "Life and Work of Wilbur Wright," which was read in 1916 as the fourth Wilbur Wright Memorial Lecture, I visited America to collect material for this lecture. During my stay, which extended over several months, I also studied the practical side of aviation and, at the age of forty-seven, made over a hundred flights on the "unstable" Wright machine. While in Dayton I was allowed to examine, with the privilege of copying, much of the personal correspondence and diaries, as well as the records of the early purely scientific work, of the Wright Brothers. I saw the original balances and twenty or thirty (out of the great number) of the original test surfaces with which the Wright Brothers in 1901 made thousands of measurements in a wind tunnel of the lift and drift and the travel of the centre of pressure on plane and curved surfaces. Copies of the tables obtained from these tests were also given to others who were interested in the problem of flight.

These laboratory measurements (*Century Magazine*, September 1908, pp. 646-647) covered a field many times greater than had been covered by the work of all other experimenters together. But the importance of the measurements lay in their accuracy. These tables did not agree with the measurements made by Langley or by any of the other experimenters. The Wright Brothers, finding that all marine propellers at that time were based upon empirical formulæ, made a study of propellers by analysing the various dynamic reactions. From these studies they evolved a theory. The propellers used on their first power machine were probably the first ever designed from theory and not from experiment. They made extended studies into the principles of equilibrium, and in this field made important scientific discoveries. Their mechanical means for carrying some of these principles into effect were patented, and the resulting litigation attracted so much attention as to cause the scientific work upon which the patents were based to go without notice. It was upon their own tables and other scientific work that the Wright Brothers built their first power machine.

These scientific experiments were made entirely at the expense of the Wright Brothers themselves, and with no thought or expectation of any other reward than the satisfaction of discovering things unknown before and the honour that naturally comes as a result. It was not until they attempted to build a power machine to carry this scientific knowledge into practical use, an expense too great for their small means, that they took out patents.

My address on the "Langley Machine and the Hammondsport Trials" was not a criticism of Langley nor of his scientific work. This was not a point at issue in my paper. But since the writer of the articles in NATURE now brings this into the discussion, I feel that some of his statements should not be allowed to pass uncorrected.

NATURE is in error in attributing the discovery to Langley of the inherent stability effect of the dihedral angle of the wings adopted by Langley in his models. This method of maintaining lateral stability in calm air was published by Sir George Cayley a hundred years ago, and was used by Penaud in his flying models in 1870 and 1871. It has never yet been solely relied on for lateral balance in actual human flight, having been always supplemented by aileron control.

The writer in NATURE says: "So far back as July 23, 1891, a paper on his (Langley's) experimental researches is to be found in NATURE, showing that the flight of a man-carrying aeroplane was possible, and enunciating the fundamental principles for obtaining a design." The demonstration referred to as "showing that the flight of a man-carrying aeroplane was possible," was stated on page 107, "Experiments in Aerodynamics," where Dr. Langley says, "such mechanical flight is possible with engines we now possess, since . . . one horse-power rightly applied, can sustain over 200 pounds in the air at a horizontal velocity of over 20 meters per second (about 45 miles an hour) and still more at still higher velocities." This statement was based upon the mistaken principle published by Sir George Cayley in Nicholson's *Philosophical Journal* of November, 1809, and accepted by most experimenters thereafter, that the pressures on a plane were normal to the surface of the plane, and that the drag was equal to the lift multiplied by the tangent of the angle of incidence. Langley's actual measurements did not confirm this theory, but he assumed (page 65, "Experiments in Aerodynamics") that if he had made certain modifications in the planes he was measuring other results would have been secured which would have confirmed it. It was this assumption that formed the basis of his demonstration that one horse-power would sustain 200 pounds at a speed of 45 miles an hour. As a matter of fact his actual measurements (page 64) showed that one horse-power could carry only 60 pounds at 45 miles an hour.

The other fundamental principle enunciated by Langley in 1891 was that known as the "Langley Law," which was that the faster an aeroplane be flown the less will be the power required to sustain it. The fallacy of this law is well known to all aeronautical engineers to-day, but up to 1910 this was generally considered as Langley's chief contribution to the science of aerodynamics. In that year when the Regents of the Smithsonian Institution decided upon the placing of a bronze tablet in the Institution commemorating Langley's work in aerodynamics, they ordered the following legend to be inscribed upon it:—

SAMUEL PIERPONT LANGLEY
1834–1906
SECRETARY OF THE SMITHSONIAN INSTITUTION
1888–1906.

AERONAUTICS:

LANGLEY LAW: "These new experiments show that if in such aerial motion there be given a plane of fixed size and weight, inclined at such an angle, and moved forward at such speed that it shall be sustained in horizontal flight, then the more rapid the motion is, the *less* will be the power required to support and advance it."—Langley, "Experiments in Aerodynamics," 1891, p. 3.

"I have brought to a close the portion of the work which seemed to be specially mine—the demonstration of the practicability of mechanical flight."—Langley Aerodrome, Smithsonian Report, 1900, p. 216.

FLIGHTS:

Steam model, May 6, and November 28, 1896.
Gasoline model, August 8, 1903.

Before the tablet was cast, the Wright Brothers were consulted as to the advisability of using this inscription and they, not wishing that anything discreditable to Langley should appear on the tablet, Mr. Wilbur Wright wrote a letter to Secretary Walcott, from which the following is quoted:—

"I have often remarked to my brother that Prof. Langley was ill-fated in that he had been especially

criticised by his enemies for things which were deserving of highest praise and especially praised by his friends for things which were unfortunate lapses from scientific accuracy. I should consider it both unwise and unfair to him to specially rest his reputation in aerodynamics upon the so-called Langley Law, or upon the computation which gave rise to it, as they do not seem to represent his best work. The particular computations which led him to enunciate this law are found on pages 63-67, 'Experiments in Aerodynamics.' A careful reading shows that he never actually tried the experiments of which he professed to give the result. . . . It is clear from the Doctor's statement that he never demonstrated by direct experiment that weight could be carried at the rate of 200 pounds per horse-power at 20 meters per second, nor that the power consumed decreased with increase of speed up to some remote limit not attained in experiment. He merely assumed that he could have done it by varying the experiments a trifle and based the so-called Langley Law on this mistaken assumption."

The Regents of the Smithsonian Institution adopted this suggestion and the Langley Law was not inscribed on the tablet.

The article in NATURE of November 3 states that "the Wright Brothers are equally clear in their acknowledgment of Langley's work," and gives a quotation from them to support this idea. This quotation, taken in connection with the suggestion of the writer in NATURE, may have carried to some readers the erroneous impression that the Wright Brothers acknowledged an indebtness to Langley for his scientific work. This was not the fact. The quotation given makes no reference whatever to Langley's scientific work. It is simply a generous acknowledgment by the Wrights at the time of Langley's death for the inspiration received from his faith in the possibility of human flight, and containing an expression of gratitude for information as to books on the subject of flight other than those they had already read. The Wright Brothers have also acknowledged their indebtedness to Chanute, Mouillard and others, but have always made it clear that their greatest debt was to Lilienthal.

GRIFFITH BREWER.

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SOME difficulty is felt in continuing a discussion of the relative merits of the great pioneers in aviation, Prof. Langley and the Wright Brothers, since they are all entitled to our esteem, and comparison seems to be unnecessary. Mr. Griffith Brewer does not appear to dissent from such a general statement, but one suspects that his enthusiastic admiration for the work of the Wright Brothers has led him to make extravagant claims.

It is very surprising to hear that "the Wright Brothers first established a scientific basis for aeroplane design," and that their laboratory measurements "covered a field many times greater than had been covered by the work of all other experimenters together." The only publication cited in support of this contention occurs in two pages of the *Century Magazine* in 1908, and readers of scientific literature in aeronautics will realise that they do not know where to look for data based on the work of the Wright Brothers. Indeed, Mr. Brewer indicates that this must be so when he says, "While in Dayton (in 1914) I was allowed to examine, with the privilege of copying, much of the personal correspondence and diaries, as well as the records of the early purely scientific work of the Wright Brothers"; apparently the work was not publicly available. Is it then strange that one should look to Langley as the scientific pioneer, since he took the normal steps of a man of science and published complete accounts of his results as he obtained them?

Mr. Brewer refers to the "Langley Law" that the faster an aeroplane be flown the less will be the power required to sustain it. He says: "The fallacy of this law is well known to all aeronautical engineers to-day, but up to 1910 this was generally accepted as Langley's chief contribution to the science of aerodynamics." The inadequacy of the law is evident now, but it is still at least partly true; in the case of the most modern aeroplanes the horsepower for flight decreases as the speed increases from the least at which support can be obtained. The increase of power required to increase the speed of the modern aeroplane above a certain limit is due to the light-weight engine, a factor which did not come into consideration in early practice. The error of unsound extrapolation outside the experience of the day was made, but only superficial observers could regard the enunciation of the law as "Langley's chief contribution" to aeronautical research.

One can only disagree with Mr. Brewer in his review of the situation and regret that this aspect of pioneer work in aviation was introduced in the tone of the paper on "The Langley Machine and the Hammondsport Trials." The point of the paper was not so much missed, as suggested by Mr. Brewer, as countered owing to the fact that the statements therein did not carry conviction. One of the articles in NATURE intimated this in the suggestion that the Royal Aeronautical Society should take up the matter and after full investigation issue an official report. The views on the Langley aeroplane expressed by Mr. Brewer cannot be accepted as final although given in all good faith.

THE WRITER OF THE ARTICLES.

Some Biological Problems.

DR. CUNNINGHAM (NATURE, February 9, p. 173) cannot be more weary of this discussion than I. It is many years since I, becoming doubtful, first tried to discover the precise meaning of certain biological key-words. To this day I have not succeeded. It has been my misfortune to encounter authoritative people who, instead of perceiving that I was genuinely puzzled, thought I might do "much harm by leading many who have no special knowledge of heredity and evolution"—*e.g.* Professors Goodrich and Bayliss—"to distrust the work of those who are engaged in research on these subjects." May I suggest that in this matter authority and regard for public opinion are out of place. Most biologists profess to know the meanings of their terms; but there is no agreement, and no definitions can be framed which cover the whole of common and accepted usage. A science which lacks a precise and significant means of expression labours under paralysing difficulties.

Dr. Ruggles Gates thinks that a variation is a character. Surely he is mistaken. When one individual varies from another (*e.g.* child from parent) the difference is revealed in a character. If this new character becomes established in the species, it remains a character; but, even colloquially, it ceases to be a variation. How then can a variation be a character? A variation cannot be thought of without a comparison, explicit or implicit, between two separate individuals; a character can always be thought of without such comparison. Evidently, then, a variation is not a character, but an unlikeness between two individuals which is displayed in a character. When we

say that a variation is innate *or* acquired we know exactly what is meant—*i.e.* that a difference between two individuals is germinal *or* somatic, a product of nature *or* nurture. For example, if B differs from A in that he has a sixth digit and a scar, he varies innately (not by acquirement) in the case of the digit, and by acquirement (not innately) in the case of the scar. But when we say that the digit itself is innate (not acquired) and the scar itself acquired (not innate) what can we mean? We are now comparing not separate individuals, but two characters of the same individual. Obviously the digit as such is no more germinal, no more a product of nature and evolution, no less somatic, no less a product of nurture than the scar. How then is the one more innate or acquired than the other? Our terms "innate" and "acquired" are now unmeaning or else they have new meanings. But, as I say, no new meanings can be thought of which cover the whole of established usage. All this would not matter were it not for its consequences.

When it is said that an innate variation is inheritable we know exactly what is meant—*e.g.* that the descendants of B will tend to reproduce the digit (will tend to differ from A) even when reared under the same influences as A. Again, when it is said that an acquired variation is not inheritable, we know exactly what is meant—that B's descendants will not reproduce his scar when reared under the same influences as A. But when it is said that innate characters are inheritable and that acquired characters are (or are not) inheritable, what is meant? Either the word inherit has now no meaning, or in this single sentence it has two directly contrary meanings—inherit when applied to innate characters, and non-inherit (*i.e.* vary) when applied to acquired characters. We are now fully immersed in that fog of words in which, except for a brief interlude in Darwin's time, biology has strayed for a century.

The trouble began in the popular notion that, like Topsy, some (*i.e.* innate) characters "just growed," while others are acquired through some influence or other and may become, through "centuries" or "generations" of experience, "innate" in the race. Lamarck formally introduced this popular notion to science. His second law has been disputed and shown to be inconsistent with the first, but the first has been accepted without question. Yet it is crammed with obviously erroneous assumptions. It is not true that "In every animal that has not passed beyond the term of its development, the frequent and sustained use of any organ strengthens it, develops it, increases its size, and gives it strength proportionate to the length of time of its employment. On the other hand, the continued lack of use of the same organ sensibly weakens it; it deteriorates, and its faculties diminish progressively, until at length it disappears." (1) No character is in any clear sense of the words more innate or acquired than any other. (2) In our own bodies are many characters—*e.g.* hair, teeth, external ears and genitals—which do not develop in the least in response to use, or atrophy in the lack of it. Only some characters develop in response to use, and only such characters atrophy in the lack of it. There is no evidence that the development of any characters in low animals is influenced by use. On the contrary, the power of so developing appears to be, relatively speaking, a late and a high product of evolution. But as to that I shall have something to say when trying to trace evolution from the physiological standpoint. (3) Lamarck's first law dimly implies that which is more clearly implied in the writings of succeeding biologists—that although all characters develop somewhat in response to use, no characters develop greatly in that way; the actual truth being that, from birth onwards, much the greater part of the growth of the higher animals is made in response to that influence.

For millions of years Nature fashions a species to develop in response to an influence (*e.g.* injury or use). The race persists because its individuals grow in that way when need arises. At long last a biologist observes such a character—*e.g.* scar, or blacksmith's muscles. For no particular reason he calls it "acquired," and supposes that evolution results from the "transmission" of such traits—a wonderful thought, for he must know that regeneration and use-acquirements are products of evolution. For half a century his fellows agree. Then some one denies not the fundamental error, not the special acquiredness of the character, but only its inheritability. Thereafter, controversy, founded in the best scholastic style on three misused words and a number of unverified assumptions, rages for half a century. Presently a majority are convinced that acquired characters are not transmissible. Thereupon some biologists devote their energies to discovering what characters are innate and therefore inheritable, and others to discovering what characters are inheritable and therefore innate. Hedged about by her extraordinary terminology, biology becomes isolated from a number of kindred sciences and studies—physiology, psychology, medicine, history, pedagogy, and the like. Of what use is it to the students of these studies to learn that a character is innate or acquired? They want to know what causes it to develop. Of what uses is it to the biologist to know how a character develops? He wants to know whether it is innate or acquired. Meanwhile many problems, mainly psychological, social, and medical, of vast importance, on which the whole future of the race depends, await solution and the driving home of the truth by the weight of scientific proof and united scientific conviction. But all these problems are too big for the subsidiary sciences. Their students are too few in number. Moreover, in every case the evidence is derived from more than one science. Only biology, which sits at the hub whence radiate all the studies that deal with life, is in a position to deal with them, and then only if it has a clear and precise medium of expression. I daresay many biologists think I am vapouring. But, if they wait, I think they may perceive a method in my madness. This much I will permit myself to say: that unless biology awakens from her long sleep, our modern civilisation is likely to smash, just as old Rome smashed and for the same reason—because there is not enough intelligence left to run a society grown very complex.

According to Dr. Cunningham, biologists bestow the descriptions "innate" and "acquired" on characters which develop in response to internal and external stimuli respectively. That is to say, "innate" and "acquired" are supposed by him to be technical terms which have meanings quite other than their ordinary dictionary meanings. But:—

(1) Before this discussion began no one ever thought of such technical meanings. On the contrary, as attested by all literature, biologists have genuinely believed that some characters are really innate and others really acquired. Hence the synonyms—germinal, blastogenic, plasmogenetic, somatic, somatogenetic, and the like—which were coined to give definition and emphasis to this belief.

(2) Light, heat, moisture, gravitation, food, injury, and the like are all external influences; and of them, the only one which is commonly regarded as evoking acquired characters is injury. On the other hand, hormones and functional activity (use) are internal influences; and since hormones act from outside the characters they influence, whereas use acts from within, the latter is the most internal of all stimuli. But use is supposed to be more especially *the* influence

which evokes acquired characters. Clearly internal, just as much as external, stimuli evoke what are called "acquired characters."

(3) As a fact, biologists when classifying characters as "innate" and "acquired" have not in practice been influenced by the kind of stimuli which have evoked them. As again all literature testifies, they have, in accordance with popular usage, called all characters which develop in response to any very glaringly obvious stimulus acquired. For example, they do not call the musculature of the child, the youth, and the ordinary man "acquired"; but they do bestow that name on the musculature of the blacksmith, though the latter develops in response to precisely the same influence. Any number of similar examples might be named.

G. ARCHDALL REID.

9 Victoria Rd. South, Southsea, Hants,
February 25, 1922.

A Rainbow Peculiarity.

EVERY one has observed a brilliantly coloured rainbow and also the secondary bow situated some distance on the outside of the primary. Is it a fact of general observation that the whole area of the inside of the primary bow is brighter than the region outside?

It was not until the winter of 1913 that this bright inner region was brought to my notice on a photograph I secured on December 1 of that year. On the morning of that day one or two heavy showers passed from S.W. to N.E., traversing the ground to the north of the Norman Lockyer Observatory. The primary bow in question was distant about one mile to the north of the observatory, as could be judged from the spot where the rainbow ended on the ground. An attempt was made to photograph the bow with a 4×5 screen focus Kodak using the ordinary Eastman film, and on development it was found that the light from the interior area of the bow had acted on the film in a much more actinic manner than that on the outside—or, in other words, the area inside the bow was brighter than that on the outside. The accompanying illustration (Fig. 1) gives a reproduction of the photograph.

FIG. 1.—Rainbow photographed on December 1, 1913.

I somewhat doubted the reality of this appearance until I had taken another photograph of a similar nature, and an opportunity occurred in December of last year.

FIG. 2.—Rainbow photographed on December 22, 1921.

On December 22 numerous showers were passing to the northward of the observatory, and I photographed three different rainbows during the morning. They were not so brilliant as that photographed in 1913, but yet sufficiently bright to record the same phenomenon. One of these photographs is reproduced in Fig. 2, and a comparison of the intensity of the distant landscape inside and outside the primary bow corroborates the previous photograph.

These photographs thus establish a fact in Nature which appears to have been rarely noticed visually. Kämtz in his "Lehrbuch der Meteorologie" (vol. 3, p. 158), a book which was published so long ago as 1836, writes on the subject as follows:—"When a rainbow with very pronounced colours is projected against a dark cloud, the sky above the first bow is darker than that underneath. If we follow the path of light in our spherical drops and remember the limiting values which have been given above, we receive none of the inner surface reflected rays from any drops which lie higher than those in which we found the maximum and which form the bright bows; lower-lying drops also send out rays from the inner back surface, and, although these more or less diverge, they tend to produce an undoubted brightness under the bow. The drops lying above the bow also send out reflected rays from their near sides, while from the drops lying under the bow we receive rays from the far side."

Following this extract Kämtz states that he has to thank Brandes for directing his attention to this phenomenon, and gives a reference to Gehler's "Wörterbuch," *Nach. Astr.*, vol. 7, p. 1324.

WILLIAM J. S. LOCKYER.

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Flowering Dates of Trees.

REFERRING to Mr. J. E. Clark's interesting article on the above subject in NATURE of February 16, I would suggest that a consideration of the different variations of temperature between Falmouth and London will help to solve the problem. From phenological observations I have made at Falmouth for many years past, it would appear that on an average this district is earlier than nearly all other parts of England in January and February by about a fortnight, but that after those months the lead is lost and the flowering and leafing of trees, etc., are retarded by our situation being near the coast line, where the waters of the European current play such an important part in lowering the land temperatures in summer and raising them in the winter. It is not always sufficiently realised how much longer the sea requires than the land to gain its summer heat and then to lose it again. Thus we find from the records of 41 years that the mean temperature of the sea in December is 50·1°, whilst in January, February, March, and April it is less, viz. 48·0°, 47·0°, 47·3°, and 49° respectively.

The following table (1920 being taken at random) shows that in January and February our mean temperature is higher than about London, but during March, April, and markedly in May, it falls behind and it is only natural that the effect on the flowering and leafing of trees, etc., should be as described by Mr. Clark.

1920.	FALMOUTH. Mean of daily Max. and Min.	FALMOUTH. Mean for 50 Years, 1871-1920.	FALMOUTH. Mean of daily Maxima.	KEW. Mean of daily Max. and Min.	KEW. Mean of daily Maxima.
		°	°	°	°
January	44·4	43·4	49·3	42·7	47·5
February	46·1	43·4	50·7	43·4	49·8
March	45·5	43·9	51·5	46·6	54·1
April	48·7	47·5	54·1	49·3	55·2
May	53·4	52·2	59·3	55·6	63·9

WILSON LLOYD FOX.

Falmouth, February 24, 1922.

Where did Terrestrial Life Begin?

IN reference to Mr. Dines's letter in NATURE of February 16, if the diurnal variations in temperature and humidity on a mountain summit in the early earth would have been smaller than at sea-level, my objection to Dr. Macfie's theory would certainly not hold. But Mr. Dines remarks that, assuming some stratification of the atmosphere, the stirring up of the lower levels might cause a temporary raising of the temperature at higher levels, which is the basis of my objection. Mr. Dines points out that if the early atmosphere had been homogeneous, mountain summits could not have been warmed by ascending air, while if the air had been stratified vertical movements would have been impossible; but that dilemma does not seem applicable to the conditions likely when the earth had just cooled down to a temperature at which life was possible.

My conception of the probable geographical conditions at the dawn of terrestrial life is that the seas would have been small, but were growing from water discharged from steam vents, which would have kept the lower air hot and saturated. Above the steam-charged layer the air temperature would have fallen quickly (as the surface would have received less heat from the interior and have lost more by radiation), so that the cooling by expansion of air rising up a mountain side would have been small and might have been largely counteracted by latent heat set forth by the condensation of moisture. Distrustful of my own capacity in thermodynamics, some years ago I asked an expert on that subject, in reference to another problem in primeval geography, whether the last condition was possible, and he replied that it was. The geographical conditions which would seem most favourable for spontaneous generation from some inorganically formed carbohydrate would be in a moist atmosphere in which the temperature would have been practically uniform. Unless those conditions held on a mountain summit, some lower position for the origin of life would seem more probable.

J. W. GREGORY.

February 20, 1922.

The Name of the Gid Parasite.

IN 1910 (U.S. Dept. of Agriculture, Bureau of Animal Industry, Bull. 125) Dr. Maurice C. Hall published a most interesting historical account of the gid parasite, a cestode worm which is exceedingly destructive to sheep. He showed that the first available specific name for the worm was *Taenia multiceps* of Leske, 1780. At the same time he rejected the familiar name *Coenurus* of Rudolphi because Goeze in 1782 had said that the parasite might be called "Vielkopf (*multiceps*)." I protested at the time to Dr. Hall that "multiceps" could scarcely be taken as a valid generic name. Goeze was not a binomial writer; he actually called the gid parasite Taenia *vesicularis cerebrina*. *Multiceps* seems to have been introduced simply as the Latin form of the common name proposed, *vielkopf*. Now, after the passage of years, I again have occasion to refer to the gid parasite and I find no ground for altering my opinion. Apparently the animal should be called *Coenurus multiceps* (Leske). The matter is important, on account of the injuries caused by the parasite, and consequent frequent references to it. I observe that Railliet and Henry (1915) and Railliet and Marullaz (1919) accept *multiceps* as a valid generic name.

T. D. A. COCKERELL.

University of Colorado, Boulder, Colorado.

The Weathering of Mortar.

IN regard to statements in NATURE of June 23 and July 21, 1921 (vol. 107, pp. 523 and 652) to the effect that the curious ridges and furrows which occur in mortar in walls are due to the segregation of lime, I would invite attention to a note in Proc. Dorset Nat. Hist. and Antiq. Field Club, 1906, vol. xxvii. p. xxxii, giving an account of an exhibit of mine of a series of pieces of mortar from a wall showing the early stages of the development of this phenomenon. The appearance is caused by the growth of moss in minute shrinkage cracks in the mortar, the sides of the cracks being gradually disintegrated by the roots of the moss, until the final stage of ridge and furrow is reached and the moss, not having sufficient root-hold, falls out when dry.

I may add that since then I have tested the mortar in the ridges and also some from the general body below the surface, and can find no difference in the proportion of lime contained in the two.

NELSON M. RICHARDSON.

Montevideo, near Weymouth, February 24.

Cancer Research.

By DR. J. A. MURRAY.

DURING the last twenty or thirty years the above title has been very frequently the text for reviews, summaries and editorial articles, and might in other circumstances be regarded as covering an over-written subject. The wide interest taken in cancerous diseases—an interest stimulated by the apparently increasing toll of this malady which the mortality figures of the Registrar-General reveal—suggests that the editorial request for a further article on the same theme should not be neglected. Recently the general Press has contained the announcement of Lord Atholstan's offer under certain conditions of a prize of 22,000*l.* for the discovery of a medical cure for cancer, whilst this has been followed by Sir William Veno's prize of 10,000*l.* The final form in which these sums will be applied to the stimulation, and perhaps the subvention, of cancer research has probably not yet been definitely decided, but both gifts can be looked upon as concrete examples of the importance which men attach to a solution of the problem of cancer.

At the present time we have in this country two important and outstanding diseases, namely, cancer and tubercle, both of which are great destroyers of human life. The latter is certainly the more important in an economic and social sense for it attacks people at a much earlier age, but nevertheless it does not seem to have the same hold as cancer on the imagination of the public. It would almost seem as if the *spes phthisica,* the illusory hope of recovery often entertained by the almost moribund consumptive, had spread from the victim to his fellow-man. The prime cause of tuberculosis has been known for forty years, yet treatment is still very unsatisfactory; in cancer the cause is still unknown, and a wider field for investigation is presented, as well as one offering the attraction of the unknown.

Physicians and surgeons are not alone in entertaining the interest thus awakened, but share it with a wider army of pathologists, physiologists and biologists, who may regard cancer as a perverted form of growth perhaps induced by an aberrant type of metabolism. If we restrict our survey to the period of the war and the following years, we find that although research was greatly curtailed, especially in Europe, it did not cease entirely; since the war, work has been resumed and certain progress made. To-day, work is being done even in impoverished Austria, and from Japan in the East to the United States in the West, from Denmark to the Argentine Republic. Investigation into the nature of cancer is almost as widespread geographically as the disease itself.

It is at no time easy to formulate a working hypothesis for attacking a biological problem, and it is especially difficult in the case of the ill-defined one we are considering; but if the attempt be made to analyse the different lines of inquiry adopted, this might profitably be done by arranging them according to their bearing upon the theory that cancer is caused by an extraneous parasite. The parasitic theory has been in the field for many years, but from the opening of the present century it did not claim so many adherents until about ten years ago, when its advocates had their view strengthened by the discovery of a peculiar sarcoma in fowls which could be transmitted by a porcelain candle filtrate, and presumably contained one of the filterable viruses. The exact relation of this chicken sarcoma to the true neoplasms is still a matter of uncertainty, but the failure to repeat this experiment with tumours from other animals leads one to suppose that their nature is essentially different. A similar comment applies to the infective venereal tumour of dogs, a sarcoma-like growth transmitted by coitus, especially amongst bull-dogs. Here, again, it is no easy matter to define the relationship with the infective granulomata on one hand, or with the true neoplasmata on the other.

A great many of the opponents of the parasitic theory of cancer believe in the efficiency of "chronic irritation" as an actual inducer of the cancerous transformation of a tissue. By chronic irritation they usually mean a prolonged succession of chemical or physical insults to a group of cells, these insults being of a degree which does not destroy the vitality of the cells but serves to excite their powers of growth and reproduction. That cancerous disease may supervene in tissues maltreated in this way is shown in a wide variety of cases, of which there may be cited chimney-sweeps' cancer, "kangri" cancer, the cancer of X-ray workers, and the cancer developing at the site of a long-standing ulceration.

All these instances lead directly to the attempt to produce cancer experimentally, but it is only within the last few years that any measure of success has attended the experiments. The production of cancer has been most successful in rabbits and mice in which a small skin area has been painted for a period of six to twelve months with coal tar. About half the animals thus treated show tumour growth at the treated site, and the method promises to be exceedingly useful for studying the conditions affecting tumour origin. Another method of producing cancer experimentally is less straightforward than the preceding, but about equally efficacious. In this a chemical or physical agent is not applied but the irritation produced by the presence of a gross parasite is employed. The artificial infection of rats by a species of nematode, *Gongylonema neoplastica,* leads to the overgrowth of the squamous portion of the stomach and in a fair percentage of cases to the development of cancer. Sarcoma of the liver of rats can also be produced with ease by the simple expedient of infecting the animal with ova of the cat tapeworm, *Taenia crassicollis.* All three methods seem likely to further our knowledge of the etiology of the disease.

The search for the cause of cancer in a developmental (embryonic) abnormality does not appear now to command many followers; it is at best a very fatalistic line of thought, and discouraging to all but the most robust-minded.

Starting from an already established tumour, much work has been done upon observing the characters of

the growth exhibited and the nature of the differentiations displayed by the tumour cells. The discovery of the transplantability of tumours of the lower animals has provided much material for this line of research, but the many attempts made to fix on any one outstanding character of tumour cells differentiating them sharply from normal cells have been unsuccessful. As before, we are confronted with the unexplained and unco-ordinated powers of proliferation shown by the tumour cells. The discovery that animals could be rendered resistant to transplanted tumours raised hopes that it might be possible to elicit an immunity towards cancer in an animal affected spontaneously, but these hopes are now considerably abated.

A start has also been made to ascertain the food requirements, general and special, of the tumour cells, but these experiments are still too slightly advanced for us to know whether any result of positive value will be obtained.

Research into the treatment of cancer other than surgical has produced many empirical experiments and observations, but, apart from the extended knowledge of radio-therapy, nothing of importance has come to light. In the field of radio-therapy, the manner of action of the rays used, and the way in which they induce destruction of cancerous cells, still offers an unsolved problem of high importance. In conclusion, it may be predicted that progress in cancer research will in large measure be closely co-ordinated with that in the ancillary sciences.

The Mechanism of Heredity.[1]

By Prof. T. H. MORGAN, Columbia University, New York City, U.S.A.

III.

Further Relations between Chromosomes and Heredity.

IN examining the chromosomes for a stage when "crossing-over" might be possible, we turn naturally to the time when the members of each pair come together. This occurs once in the history of every germ-cell. In many accounts it has been shown that the members of each pair come to lie side by side throughout their length. Even more interesting is the fact that just prior to this union the chromosomes have spun out into long, thin threads. There are also

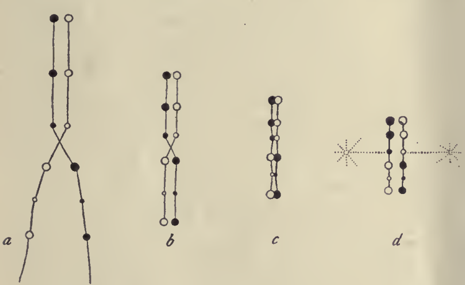

FIG. 16.

several detailed accounts showing that at this time the two chromosomes of each pair may actually twist about each other in one or more turns (Fig. 16). They then come to lie side by side and appear as a single thread that shortens preparatory to entering upon the first maturation division. Here, apparently, we find realised a condition that might make interchange possible between the members of a pair of chromosomes, for if the threads fuse where they cross each other and the ends on the same side unite, the interchange of pieces will be accomplished. From the nature of the case it would be almost impossible to demonstrate that the twisted threads do break and make new unions at the crossing point. It is true that there are certain later stages that lend, perhaps, some support to the view that breaking and reunion have occurred, as Janssens has pointed out, but it cannot be claimed that this evidence does more than give, on such an assumption, an account consistent with certain configurations he describes. Here the case must rest for the present. The genetic evidence is clear and far in advance of what the cytologist is able to supply. But, nevertheless, it is very important to find that, so far as the cytological evidence goes, it furnishes a great many of the facts essential to the kind of process that the genetic evidence calls for.

The Number of the Linkage Groups and the Number of the Chromosomes.

When Sutton in 1902 directed attention to the fact that in the behaviour of the chromosomes at maturation there was supplied a mechanism for Mendel's two laws, it was evident that the number of independently assorting hereditary characters would be limited to the number of the chromosome pairs characteristic of each species of animal and plant, provided the chromosomes remain intact from generation to generation. The integrity of the chromosome was held, in fact, by a few leading cytologists at that time, notably by Boveri, on evidence which, if not complete, was the best then obtainable. In the circumstances, the later discovery of the agreement between the number of chromosome *pairs* of *Drosophila melanogaster* and the number of its linkage groups was of paramount importance for the chromosome theory. In this species the number of known hereditary characters is so large (more than 300 in all) that this relation can scarcely be due to a coincidence, especially when the whole evidence concerning chromosomes and heredity is taken into account.

It is true, with the possible exception of the garden pea (where there appear to be as many independently

[1] Continued from p. 278.

Mendelising pairs as there are chromosome pairs, namely, seven), that this relation has as yet been established only for species of Drosophila. But it is also true that not a single animal or plant has yet been found in which the number of known hereditary groups of genes is greater than the number of chromosome pairs. It is to be anticipated that some one will before long announce such a discovery, for it is very probable that if two linked genes happen to be so far apart as to give 50 per cent. of crossing-over, they will appear to be in different groups. But such a situation need cause no alarm when (or if) it arises, and will not, of course, refute the correspondence of linkage and chromosomes, unless it can be shown that each such member belongs to a different linkage system. Furthermore, it is to be anticipated that where compound groups of chromosomes exist, such as have been described in some grasshoppers and bugs, peculiar relations are likely to be found.

The evidence from two species of Drosophila other than *D. melanogaster* should also be taken into account. In *D. obscura* Lancefield has shown that there are five pairs of independently assorting characters. There are also five pairs of chromosomes. In *D. virilis* Metz has found six pairs of chromosomes, and up to the present at least five independent loci. The fact that no crossing-over takes place in the male makes the evidence for the independence of the pairs practically certain.

Origin of Mendelian Genes.

Mendelian heredity is sometimes slightingly referred to as a particular kind of heredity dealing with characters that are due to losses of wild-type *characters*. This view ignores some significant facts and considerations. To argue that because a *character* is lost or modified there must be a corresponding loss in the *germ-plasm* is clearly a *non sequitur*. Each organ of the body is the end result of a long series of stages in embryonic development. Any change in any one of the stages would be expected to alter the end product. There are no grounds for assuming that such changes must necessarily be losses, although losses also might sometimes produce such effects. The argument has all the earmarks of reasoning by analogy.

However, the discussion need not rest any longer on philosophical grounds, since we have crucial experimental data which show that loss of a character is not necessarily due to loss of a gene. One case will suffice. In addition to the white-eyed mutant of Drosophila there are ten other eye colours that lie in the same locus. Obviously there cannot be ten kinds of absences. The only other possible explanation of ten absences would be that there were ten genes here so close together that crossing-over does not take place. Hence they appear to be in the same locus. Now, fortunately, the origin of these ten mutations is known, and shows—if they were really a closely linked nest of genes—that when the last one appeared there must have been at the same time mutation in nine other genes in order to get the results. The rareness of mutation precludes such an interpretation. Attempting to save the interpretation of recessive characters as due to absence of genes, it has been argued that perhaps only a part of the wild-type gene is *lost* when a new recessive character appears. It is, however, not obvious why the hypothesis needs to be saved. It is simpler and suffices to cover our ignorance to say that a change has taken place.

There is another question connected with these multiple allelomorphs—changes in the same locus—that is very important. Any given individual may normally have at most any two of the genes (one derived from the father, and one from the mother), but never more than two. When there are two such mutant genes present they behave towards each other in the same way as does any mutant gene towards its wild-type allelomorph. It follows that the Mendelian behaviour is not a peculiar relation of a mutant gene to a wild-type gene. It would seem, therefore, highly probable that wild-type genes behave in this way towards each other, and, in fact, where two wild types exist in Nature that differ in a single allelomorph, they are found to give a Mendelian segregation when brought together.

The discovery of a large number of mutants in the same species may be expected in time to furnish some idea of the number of hereditary genes that exist in a species, or, in other words, to tell us how many different kinds of genes *plus* the cytoplasm constitute a species. At present, even in the case of Drosophila, we are far from being able to make such a calculation. There are, however, one or two rough estimates which seem to indicate that the number of genes is more than several thousands. The upper probable limit cannot even be guessed.

How the genes bring about their effects, which are shown as modifications of the protoplasm (or by-products of it), is entirely unknown. If it seems desirable at present to limit the definition of heredity to cover only the distribution of the genes in successive generations, the result of their effects on the protoplasm becomes a problem of embryology. To many geneticists, however, no such limitation seems desirable, because it may appear that the ultimate constitution of the genes themselves can be discovered only by working backwards, through the effects produced, to the nature of the material that furnishes the first stage in the elaboration. With this pious hope I heartily agree, but in the meantime I do not think it desirable to let premature attempts in this direction interfere with clear-cut methods of research that Mendelian results supply.

Finally, the question as to whether all hereditary characters arise, or have arisen, through mutational changes in the germ-plasm similar to those found occurring to-day, can be settled only by future evidence. Guessing is scarcely worth while. One point, however, seems fairly well established—namely, that in several cases where differences in wild species have been subjected to the experimental analysis employed by geneticists for variation arising by mutation, they give the same kind of results.

Obituary.

SIR GEORGE CARTER, K.B.E.

BY the death of Sir George Carter, there passes one of the greatest figures in the shipbuilding industry of the last twenty years. He had been in ill-health for rather more than twelve months, but had not formally retired from his position of managing director of Messrs. Cammell Laird's famous shipbuilding and engineering works at Birkenhead. Sir George Carter was trained at the Royal Dockyard at Portsmouth, and furnishes another name on the list of great shipbuilders who have come from that excellent nursery, the Dockyard Schools.

Soon after completing his training at Portsmouth Sir George Carter proceeded to the well-known Tyneside firm of Messrs. Armstrong, Whitworth, and Co., where his uncle, Sir Philip Watts, was naval architect. A man of extraordinary vigour and of sound judgment, he was quickly given the important post of shipyard manager, and his tenure of this position for eighteen years witnessed the production of some very notable and epoch-making ships as well as a large extension of the firm's premises at their merchant shipyard at Walker.

Though always an important figure in the industry, it was during the last ten years that Sir George Carter came very prominently before the public, when in 1912 he became managing director of the Merseyside firm. He succeeded in extending the firm's business and premises in a remarkable manner, and when the war came in 1914 he was able to devote his whole energies to, and to utilise to the full the firm's great resources in the construction of warships.

Sir George Carter's activities were too numerous for mention in a short notice of his career, but reference must be made to the very important part he played as chairman of the Advisory Committee on Merchant Shipbuilding under the Shipping Controller in the fateful days of the early part of 1917. It was this committee that evolved the standard ship and made a supreme effort to organise the whole industry in order to simplify manufacture and increase output. Sir George also occupied many positions of importance, being a member of the council of the Institution of Naval Architects, of the Committee of Lloyd's Register of Shipping, of the Mersey Docks and Harbour Board, and of the Court of the University of Liverpool.

All those who knew Sir George Carter intimately and were familiar with his work during the war will agree that he spent himself in the service of his country and sacrificed some years of his life in its behalf.

T. B. A.

DR. H. LYSTER JAMESON.

WE regret to announce that Dr. Henry Lyster Jameson died at his home at West Mersea, Essex, on February 26, of hæmorrhage of the lungs, at forty-seven years of age. Dr. Jameson was educated at Trinity College, Dublin, where he took the degrees of B.A. and D.Sc. He spent a year at the Royal College of Science, London, and then worked at the University of Heidelberg, where he studied zoology under Bütschli. Afterwards he went to British New Guinea, where he had charge of a pearling station, and this gave him opportunities for research into the causes of pearl-formation, an investigation which he continued at the Lancashire Sea Fisheries Station in Piel, Barrow-in-Furness. There he established the parasitic theory of pearl-formation in the common sea mussel, and he extended the research later into a study of the various processes by which the orient pearl is formed, publishing a series of papers in the *Proceedings of the Zoological Society* and elsewhere. About this time his health broke down, and, threatened with pulmonary phthisis, he went to South Africa, where he was, for a time, on the staff of the Natal Education Department and, later, a lecturer at the Technical College in Johannesburg.

Some few years before the war Dr. Jameson returned to England and was appointed to a post in the Board of Education, becoming a Senior Examiner. At the outbreak of war in 1914 he was seconded for special service in the Ministry of Agriculture and Fisheries, and, later, became District Inspector for the South-Eastern Coast. At that time the slipper-limpet was becoming a pest to the oyster fisheries, and Dr. Jameson organised a system of collecting and disposing of this noxious mollusc. A very successful factory for the preparation of shell-grit from the limpets dredged up in the course of the oyster fishing was set up at West Mersea, and he was in charge of this up to the time of his death. In 1918 he became Adviser on Inshore Fisheries to the Development Commissioners and his work became largely administrative, but lately he was very active in the investigation of vitamins in molluscan shell-fish, working on this subject in collaboration with Prof. W. Bayliss.

Such was Dr. Jameson's persistent ill-health that any form of physical activity became impossible, but under this strain he developed a strong and most engaging personality and wide interests in social and economic reform movements. He was a man of great general culture, a very accomplished field zoologist, and a most lovable friend to those who knew him well. He leaves behind him a widow and two daughters.

SIR EDWARD GONNER, K.B.E.

WE record with great regret the death, on February 24, in his sixtieth year, of Sir Edward C. K. Gonner, who was for more than thirty years the Professor of Economic Science in the University of Liverpool, and whose skill and power of organisation have done much to earn for that University the high position it holds as a centre of economic teaching. The view which he entertained of the difficulty and of the importance of economic study, and which inspired him in his work, is well expressed in the address he wrote for the Toronto meeting of the British Association in 1897, as President of Section F: "This is needed by all those who, either by action, word, or vote, have a part in the direction of the destinies of a country." Again appointed President of that Section at the Australian meeting in 1914, he enforced the same moral. He published some valuable text-books on economic subjects. He served on the Royal Commission on Shipping Conferences. As chairman of the War Savings Committee for Cheshire he also rendered public service, and was appointed a Companion of the Order of the British Empire. He was promoted to a

knighthood of the same Order last year. Sir Edward Gonner's early death was due to an attack of influenza. At a time like the present when the inculcation of sound economic principles seems to be more than ever necessary, the loss of so good and practical a teacher as Sir Edward Gonner will be deeply felt.

MR. GEORGE CUSSONS.

IT is with regret that we record the death on February 10, at the age of seventy-five years, of Mr. George Cussons, the founder of the well-known firm of scientific apparatus makers of Lower Broughton, Manchester. Mr. Cussons in his early manhood gained a studentship at the Royal School of Mines, London, and upon the completion of the course became a drawing-master and also a teacher of geometry and mechanical subjects in evening classes in towns near Manchester. Having considerable mechanical skill, acquired in the course of his apprenticeship, he devised a variety of models and apparatus, which he employed effectively to demonstrate the problems arising in the course of his teaching. Finding great advantage accruing therefrom, he was induced to enter business life as a manufacturer of apparatus to be used in the demonstration of the subjects of geometry, theoretical and applied mechanics, and of physics. Among other excellent apparatus he designed and patented a much-improved Atwood's machine to demonstrate the laws of falling bodies. His firm gained well-deserved repute among Technical Institutions for the excellence and adaptability of its apparatus.

Mr. Cussons, whilst he was a student at the evening classes of the Owens College, Manchester, made the acquaintance of Osborne Reynolds, the eminent Professor of Engineering at the College, and brought to his notice certain models for use in Descriptive Geometry. He suggested various improvements which were adopted, and the models were exhibited at the National Health Exhibition of 1884, where they gained a medal for excellence. Since that time the firm has been awarded medals for the superior character of its apparatus at exhibitions held at home and abroad, and has supplied scientific equipment to practically every country in the world. It furnished a large number of models for geometrical and mechanical drawing, together with a considerable equipment, for the extensive mechanics laboratory of the Manchester College of Technology, which have proved of eminent service. Mr. Cussons was in close touch with all the principal science institutes, and was always ready to discuss any new suggestions for apparatus, and to place his practical training and his knowledge of the teaching of mechanical and physical science at the service of those concerned.

THE death occurred on January 28, in his 52nd year, of Dr. Charles Baskerville, who had been professor of chemistry at the College of the City of New York since 1904. Dr. Baskerville had previously occupied a similar post at the University of N. Carolina. He did notable work on the rare earths, and carried out many investigations in the chemistry of anæsthetics. His inventions included processes for refining oils, hydrogenation of oils, plastic compositions, reinforced lead, etc.

WE notice with much regret the announcement of the death on March 3, at fifty-five years of age, of Prof. Benjamin Moore, Whitley Professor of Chemistry in the University of Oxford.

THE *Chemiker Zeitung* reports the death on February 13 of Prof. Theodor Liebisch, of the University of Berlin, well known for his work on physical crystallography, especially in the department of crystal optics.

Current Topics and Events.

A NATIONAL tribute to the memory of Sir Ernest Shackleton took the form of a special service in St. Paul's Cathedral at noon on March 2. The service was conducted by Dean Inge and the Cathedral clergy and was short and simple but impressive and of great beauty. It included some sentences from the Burial Service, the twenty-third Psalm, the lesson from 1 Corinthians xv., the anthem "Thou wilt keep him in perfect peace," and two special hymns, "Eternal Father, strong to save" and "For all the saints who from their labours rest." The soft beauty of the perfect music was followed with striking effect by the shrill sounding of "The Last Post" by the boys of H.M.S. *Worcester*. It was impossible amid the splendour of the ceremonial and the distinguished congregation representative of the most refined civilisation not to picture in contrast the rough chapel on South Georgia and the toil-stained whalers who surrounded Sir Ernest Shackleton's grave, and the little *Quest* carrying on the mission on which he perished, tossing in the huge waves of the Southern Ocean or beset by the Antarctic ice. The congregation at St. Paul's included the widow and three children of the explorer, several of his sisters and other relatives, representatives of the King, Queen Alexandra, the Prince of Wales, the Duke of Connaught, the Colonial Secretary, the First Lord of the Admiralty, the Trinity House, and the diplomatic representatives of Norway, Denmark, Portugal, Argentina, and other countries. The Royal Geographical Society was represented by its President, a large number of the Council, and the principal officials, and many other societies and institutions sent representatives. Amongst those with special interest in the Antarctic regions were Mr. John Q. Rowett, Sir John Scott Keltie, Dr. H. R. Mill, Dr. H. O. Forbes, and a strong muster of Sir Ernest's old comrades, including Captain C. W. R. Royds, R.N., and Mr. L. C. Bernacchi of the *Discovery* expedition, Capt. W. Colbeck of the *Morning*, Sir Philip Brocklehurst of the *Nimrod* expedition, Mr. J. M. Wordie, Mr. Greenstreet, and Mr. Rickenson of the *Endurance* expedition, and Mr. Mason, who had sailed on the *Quest*, but had to return on account of his health. No doubt others were present who were not recognized in the great congregation.

MR. CAMPBELL SWINTON gave some very interesting reminiscences at one of the meetings recently held to celebrate the Jubilee of the Institution of Electrical Engineers. In particular he recalled some of the experiments carried out in 1879 by David

Hughes, whose widow, who died recently in America, has bequeathed some of his notebooks to the British Museum. These have been examined by Mr. Swinton. They prove that Hughes undoubtedly noted some of the effects now known to be due to high-frequency waves. He used a small spark coil as a generator, and a Bell telephone and a battery generally connected in series with a microphone as a receiver. The microphone apparently acted sometimes as a coherer and possibly sometimes as a thermocouple rectifier. He received signals up to distances of about a hundred yards. He noted that the effects produced were very uncertain at the distance of half a mile. When he earthed one or both ends of his transmitting and receiving circuits he got enhanced results. It has to be remembered that all this was done about nine years before Hertz's memorable discoveries. Hughes, however, seems to have had no conception that he was dealing with electromagnetic waves. He thought that the effects were due to electric conduction through the air. In a letter to *The Electrician* on May 5, 1899 (vol. xliii. p. 40), Hughes himself describes his experiments. It appears that he showed his experiments to a number of leading men of science in 1879 and was profoundly discouraged by their comments on them. In particular Sir George Stokes stated that the effects were due to ordinary electro-magnetic induction. It would be interesting to speculate what might have happened had they encouraged him to proceed with his researches. But in any case a great deal of further experimental work would have had to be done before the art of radio-telegraphy was achieved.

SIR ROBERT HORNE, Chancellor of the Exchequer, in the House of Commons on March 1, surveyed the proposals put forward by the Geddes Committee on National Expenditure, and indicated the general views of the Government concerning some of them. The two items which in the main make up the "cut" of £18,000,000 recommended by the Committee as regards education are the reduction of teachers' salaries and the exclusion from school of children below the age of six years. The Government has decided that neither of these proposals can be put into operation. The reductions adopted amount to £6,500,000 instead of the £18,000,000 recommended by the Geddes Committee. It is proposed that teachers should contribute five per cent. of their salaries towards their superannuation fund, and this will bring in a sum of more than £2,000,000. The Department of Mines is to become an integral part of the Board of Trade, and the Minister who at present acts as secretary of the Department is to be one of the under-secretaries of the Board. The Forestry Department is to be carried on and will not be abolished as recommended by the Geddes Committee. As to agriculture, the Government has decided that the grant made available by the Corn Production Appeal Act cannot be used to make up the reduction upon education and research recommended by the Geddes Committee, but has to be additional to the amount already devoted to these purposes.

THE first Scientific Reunion of the Natural History Museum Staff Association for the current year, which took place on March 1, attracted an exceptionally large attendance. Many interesting exhibits were on view, among which may be mentioned the following: Fine group of Alaskan Bighorn Sheep, consisting of a male, female, and young, recently presented to the Museum by Mr. T. R. Hubbock; selection of the mammals, birds, and insects collected by the Mt. Everest Expedition in 1921; original plaster cast prepared by Mr. F. O. Barlow of the brain cavity of the Rhodesian Skull; model made by Mr. G. C. Robson of the curious triplicate respiratory mechanism in the Ampullariidæ; specimens and model of the gigantic frogs which swallow crabs and even small mammals whole; the flower-mimicking mantid from East Africa; Cichid fishes from Lake Victoria and certain Crustacea illustrating mutation; samples of wool treated with lichen dyes with or without mordants; specimen of *Orites excelsa* from Australia showing deposit of aluminium succinate in the cavities of the wood; a meteoric stone, weighing 4½ lbs., one of the hundred that fell on October 16, 1919, at Bur-Gheluai, Bur-Hagala District, Italian Somaliland; and a series of minerals from Zermatt. Messrs. Watson & Sons gave a demonstration of their most recent microscopes and ancillary apparatus.

THE Air Ministry announces that the Civil Aviation Advisory Board, the creation of which was announced by the Under-Secretary of State for Air at the recent Air Conference, has now been set up with the following terms of reference:—"To advise generally on the development of Civil Aviation and to report upon any specific point which may, from time to time, be referred to the Board by the Secretary of State for Air." The constitution of the Board is as follows:—The Under-Secretary of State for Air (Lord Gorell), chairman; The Controller-General of Civil Aviation, Air Ministry (Major-General Sir Frederick H. Sykes); The Director-General of Supply and Research, Air Ministry (Air Vice-Marshal Sir W. G. H. Salmond); representatives of General Post Office (Brigadier-General F. H. Williamson), Air League of the British Empire (Major-General Sir W. Sefton Brancker), Association of British Chambers of Commerce (Mr. Edward Manville), Federation of British Industries (Mr. H. James Yates), Lloyds (Lieut.-Colonel Sir Frederick Hall), Royal Aero Club (Brigadier-General Sir Capel Holden), Royal Aeronautical Society (Lieut.-Colonel Mervyn O'Gorman), Society of British Aircraft Constructors, Limited (Sir Henry White Smith). The secretary of the Board is Mr. F. G. L. Bertram, Air Ministry.

WE learn from *Science* that Dr. I. C. White—who has been State Geologist of West Virginia since 1897, and is distinguished for his contributions to the geology of coal and petroleum—and Mrs. White have given to the University of West Virginia and the city of Morgantown 1911 acres of Sewickley coal, situated in Marion County. It is estimated that

the tonnage of the acreage will be approximately 15,000,000, and should yield at least 800,000*l*. over a period of years, of which the city and the University will have equal shares. The income which the University will derive from the gift is to be devoted solely for equipping and maintaining a geological department in the State University in the city of Morgantown, West Virginia. Western Reserve University has also received a noteworthy gift from Mr. Samuel Mather, of Cleveland, who has announced that he will provide funds for the erection of the new building of the School of Medicine. The estimated cost of this is about 506,000*l*.

AT a meeting of the council of the British Medical Association held on February 15, the gold medal of the association was awarded to Sir T. Clifford Allbutt, Regius Professor of Physic in the University of Cambridge, for his long and distinguished services to the profession and the association, and in commemoration of his five years' presidency of the association in the time of the great war, 1916–1921. In proposing the award, the Treasurer of the Association, Dr. G. E. Haslip, said that on all the three grounds for which the medal was customarily awarded no more fitting recipient could be found. Alike for his scientific attainments, for the measure in which he had enhanced the honour and dignity of the profession, and for his devoted services to the British Medical Association, Sir Clifford Allbutt richly merited this distinction. It was agreed that an engrossed testimonial, stating the grounds of the award, should be prepared and presented, together with the medal, at the Glasgow meeting in July next.

WE have received from The City Sale and Exchange, 81 Aldersgate Street, E.C., the sole British agents, the catalogue of microscopes and photomicrographic apparatus of the Koristka Optical Co., Milan. Koristka microscopes are obtainable for all classes of work; the objectives have a reputation for being of the highest quality, and are of the apochromatic, semi-apochromatic (fluorite), and achromatic types. A binocular form and a light aluminium travelling stand are supplied. The photomicrographic apparatus includes both vertical and horizontal forms, half-watt lamps of 100-300 candle-power constituting the illuminant. Dark-ground condensers, blood-counting apparatus, microtomes, hot and mechanical stages are also listed. The microscope stands included in the catalogue can be supplied from stock, and are approximately only half recent German prices for similar models.

THE Annual Conversazione of the Institution of Electrical Engineers will be held at the Natural History Museum, South Kensington, S.W., on Thursday, June 29.

THE Guthrie Lecture of the Physical Society will be delivered on March 24 at 5 o'clock, at the Imperial College of Science, by Prof. N. Bohr, who will take as his subject "The Effect of Electric and Magnetic Fields on Spectral Lines."

THE Chemical Manufacturers' Sub-Section of the London Chamber of Commerce, at a meeting held on February 28, unanimously adopted a resolution, "that this meeting is of opinion that the Safeguarding of Industries Act is of great potential value, and records its conviction that the establishment in this country of a Fine Chemical Industry is of the utmost national importance."

AT the meeting of the Royal Geographical Society on March 6 the president announced that all the members of the Mount Everest Expedition have now left England, and General Bruce with his two assistants from the Gurkha Regiments of the Indian Army, Captain Geoffrey Bruce and Captain Morris, must be by this time at Darjeeling making preparations for the start of the expedition at the end of this month. They will be especially concerned with the two most important matters, firstly, the organisation of the special corps of Himalayan coolies enlisted from Nepal, and the borders of Sikkim, and Tibet, and, secondly, with transport arrangements which will require very careful and methodical planning, for the expedition is larger this year than last, and is more fully equipped.

THE following were elected at the annual general meeting of the Geological Society on February 17:—*President*: Prof. A. C. Seward; *Vice-Presidents*: Prof. E. J. Garwood, Mr. R. D. Oldham, Dr. G. T. Prior, and Dr. H. H. Thomas; *Secretaries*: Mr. W. Campbell Smith and Mr. J. A. Douglas; *Foreign Secretary*: Sir Archibald Geikie; *Treasurer*: Mr. R. S. Herries; *Other Members of Council*: Mr. F. N. Ashcroft, Dr. F. A. Bather, Prof. P. G. H. Boswell, Prof. W. S. Boulton, Mr. T. C. Cantrill, Dr. J. S. Flett, Mr. J. F. N. Green, Dr. F. H. Hatch, Prof. O. T. Jones, Mr. W. B. R. King, Prof. S. H. Reynolds, Sir Aubrey Strahan, Prof. W. W. Watts, and Mr. H. Woods.

AT the annual general meeting of the Association of Economic Biologists held on February 24, the following officers and council were elected for the year 1922:—*President*: Prof. E. B. Poulton; *Vice-Presidents*: Prof. V. H. Blackman, Dr. G. A. K. Marshall; *Treasurer*: Dr. A. D. Imms; *Editors*: Dr. Wm. B. Brierley (Botany), Mr. D. Ward Cutler (Zoology); *Secretaries*: Dr. Wm. B. Brierley (General and Botanical), Dr. J. Waterston (Zoology); *Council*: Prof. V. H. Blackman, Dr. G. A. K. Marshall, Dr. S. A. Neave, Dr. W. Lawrence Balls, Mr. F. T. Brooks, Dr. E. J. Butler, Dr. E. J. Russell, Prof. J. Percival, Dr. W. F. Bewley, Mr. A. W. Bacot, Dr. J. W. Munro, Mr. A. B. Bruce.

ON Thursday, March 16, Dr. P. Chalmers Mitchell will begin a course of two lectures at the Royal Institution on "The Cinema as a Zoological Method." The Friday evening discourse on March 17 will be delivered by Prof. A. P. Laurie on "The Pigments and Mediums of Old Masters," and on March 24 by Prof. F. G. Donnan on "Auxiliary International Languages."

Our Astronomical Column.

SATURN.—This planet is now very favourably situated for telescopic study. The luminous rings are now only slightly inclined, as seen from the earth, and present but a small extent of surface and detail. The ball, however, with its various dusky bands and bright zones of different intensities, will furnish interesting features under high magnifying powers. Occasionally, white spots and other irregularities are to be seen in the belts, and markings of this kind are important and should be utilised for redetermining the rotation period. Mr. W. F. Denning points out that Saturn is akin to Jupiter in presenting a number of surface currents which differ considerably in their relative velocities. In 1903 a number of light and dark spots became visible in the north temperate region of the planet, and these indicated a rotation period of 10 hours 37 minutes and 52 seconds.

Saturn will be in opposition to the sun on March 25, and situated at a distance of 794 millions of miles from the earth.

METEORIC FIREBALLS.—A magnificent fireball is described as having passed over the southern hemisphere on January 11 last. Its flight was witnessed from the Liverpool liner *Vauban*, which arrived at New York on February 20. The fireball is described as being as large as the full moon and moving very slowly from 10 degrees above the western horizon to the eastern horizon. It occupied three and a half minutes in its flight and all the while emitted a blaze of light sufficiently powerful to illumine the sea and ship in an extraordinary degree.

On February 17, at 11·32, a brilliant meteor was observed from many places, including London, Barnet (Herts), Stowmarket, Droitwich, and Scunthorpe, Lincolnshire. As seen from places not remote from the object it appeared to be many times brighter than Venus, and its flight was fortunately witnessed by several observers who apply themselves to celestial studies, including Mr. A. King, Mr. J. P. M. Prentice, Mr. A. N. Brown, Mr. Gheury de Bray, and others. Computation shows that the meteor had a radiant at about $125° + 13°$ in Cancer, and that its height was from 62 to 29 miles from over Yarmouth to Winchester, Hants. Its luminous course extended over 41 miles and its velocity was 14 miles per second. It is remarkable how many fireballs displaying exceptional characteristics have appeared during the period from February 7 to 22 in different years.

COMPARISON OF SPEED OF BLUE AND YELLOW LIGHT.—*Harvard College Observatory Bull.* No. 763 contains an investigation of the difference in the times of the phases of the short-period variables in the globular cluster Messier 5 in Libra, as determined from photographic plates sensitised for blue and yellow light respectively. On the average the times were later in the blue light by 35 seconds, with a probable error of 70 seconds. The distance of the cluster was found by five different methods to be about forty thousand light-years, making it follow the Hercules cluster, Messier 13, as the second in nearness of those north of the equator. Accepting this distance, the speeds of blue and yellow light in the intermediate space do not differ by more than one part in ten thousand million as a maximum possible. Since any absorbing medium would cause the speeds to differ, this affords an upper limit to its amount.

THE ILLUMINATION OF THE ECLIPSED MOON.—The *B.A.A. Journal* for January contains an important article by L. Richardson discussing the action of the terrestrial atmosphere in refracting sunlight on to the eclipsed moon. Tables and diagrams indicate the amount of refraction of light at various heights above the earth. The values at heights of 0 km., 10 km., 20 km., 30 km., are 68′, 22′, 5′, and 1′ respectively; thus to reach the centre of the shadow the sunlight has to pass fairly near the earth's surface, and high mountains or clouds would intercept a good deal of it; an irregularity in the outline of the shadow in the eclipse of 1888 was plausibly attributed to cloud in the Amazon basin, or else to the Andes. The strange distortion that the sun would undergo to an observer on the moon is described.

The author deduces from theory that the centre of the shadow should be slightly brighter than the surrounding regions, and finds some support in the observations of May 1920. He constructed a model lens of concave section in printers' roller composition, with an opaque disc in the middle; when this was placed over a source of light, the brilliant ring could be seen round the dark disc, also the increase of illumination near the centre of the shadow. The bluish or greenish fringe often seen in the outer parts of the shadow is explained by stating that the sunlight that has passed high above the earth's surface would be much less reddened than that which passed low down. It is also pointed out that the varying distance of the moon from the earth is an important factor in altering the illumination in different eclipses. When the moon is in apogee it is further from the earth's "black shadow," and gets more light. After allowing for these factors, and for the mountain ranges that lie along the earth's terminator, the illumination of the moon should afford a useful index of the clearness of the zone of atmosphere that lies near the terminator.

PARALLAXES AND PROPER MOTIONS.—Mr. Van Maanen deals with this subject in *Contributions from Mt. Wilson Observatory*. No. 204 contains two important investigations, the first being a set of parallax determinations of specimen objects of various types made with the 60-inch reflector. The terms to reduce to absolute parallax have been derived from comparison with the spectroscopic parallaxes of Adams, etc. The mean parallax of 11 planetary nebulæ is of the order of 0·01″, the mean absolute magnitude is 8·4, and the mean diameter 0·06 light-year. Two Cepheids give small parallaxes of the same order as those found by Shapley from the proper motions; T Cassiopeiae, a long-period variable, has the considerable parallax 0·027″; its absolute magnitude varies from 3·9 to 9·7; two stars, Boss 500 and RR Lyræ, are notable for their high velocities, each about 200 km./sec., their absolute magnitudes being near 0; the value 0·019″ found for Nova Aquilæ is nearly the same as the accepted value for Nova Persei, 1901, while Campbell's hydrogen-envelope star (type O) and Boss 3322 (type N) are assigned parallaxes of 0·005″ and −0·002″. The radial velocity of the double cluster in Perseus is found to be −40 km./sec. and its proper motion +0·003″ in R.A. and +0·003″ in Decl. These values are so small that it is impossible to pick out cluster stars with certainty unless they are bright enough to permit their radial velocity to be determined. Tables are given of the individual motions and magnitudes of over 1500 stars.

Research Items.

THE TABOO OF WOMEN AMONG GYPSIES.—The *Journal of the Gypsy Lore Society*, now happily revived with good prospects of success, publishes in its opening number an article by Mr. T. W. Thompson on "The Uncleanness of Women among English Gypsies," which brings us back, in this England of ours, to savage taboos which Sir James Frazer has copiously illustrated in the "Golden Bough," and reminds us that the Gypsies are a foreign, oriental race established in our midst. Women, not only at special periodical seasons, are treated as impure. Gypsies will destroy any piece of crockery or any cooking utensil touched by a woman's skirt: no woman may walk over a stream or spring from which drinking water is taken, lest it may become defiled: and this power of contamination without contact applies to things like crockery: "Suppose now," said a girl, "my mother or one'm the girls had stepped over the tea-things as we was getting our teas, d'ye think my father'd ha' eaten another bite?" Women engaged in cooking never touch "red meat"—beef, mutton, or liver—but roll up their sleeves and put the meat into the pot with a fork. Men object to women using for washing up the crockery the soap they use for washing themselves. The article deserves consideration as describing a remarkable survival of taboo among a civilised race.

THE TOMB OF CONFUCIUS.—The *Museum Journal*, issued by the University of Philadelphia (vol. xii., No. 2), is devoted to an article by Mr. C. W. Bishop on "Shantung, China's Holy Land," and the tomb of Confucius. The cult of T'ai Shan, holiest of mountains, belongs to Taoism, the real creed of the common people, contrasted with that of Confucius, whose teachings represent the ideals of character and conduct of the ancestor-worshipping feudal aristocracy to which he belonged. There is also a goddess of T'ai Shan, but the most striking fact about the religion of China in feudal times is the entire absence of female divinities. Some forty miles south of the holy mountain, at Chu'u-fu, is the tomb of Confucius, a splendid temple within which is the gigantic seated figure of the sage, arrayed in royal robes, and round him statues of his principal disciples. The cemetery, said to be thirteen miles in circumference, contains tens of thousands of the graves of his descendants, perhaps the most wonderful graveyard in the world, continuously occupied by the descendants of a single man for more than two thousand years. The excellent photographs accompanying the article enable us clearly to realise this Chinese Holy Land.

NATURALISTIC ART IN EGYPT.—Under the heading "A New Chapter in the History of Egyptian Art," in the February issue of *Discovery*, Dr. A. M. Blackmann describes a new development of naturalistic art found in the tombs of the barons of Cusae, the modern Kusiyeh, about 200 miles south of Cairo. It is possible that this school of art did not originate locally, but at Heracleopolis Magna, the capital during the Ninth and Tenth Dynasties, which lasted from about 2500 to 2220 B.C. There is nothing quite so realistic and vigorous in the art of Memphis as the Cusite sculptor's representations of the lion catching a bull by the muzzle, the hartbeests, antelopes, and gazelles pursued by the hounds, and, more wonderful still, the tense, nervous figure of the noble hunter, raising himself on the toes of his right foot as he leans forward to discharge an arrow from his bow at the flying deer. Equally remarkable are the figures of two fellahin binding a bundle of papyrus reeds, the typical hulking Upper Egyptian yokels, the butt of the town-bred clerk in a coffee-house. Dr. Blackmann's review of this notable chapter in the art of Egypt is in every way to be commended.

MOUNT EVEREST MAPS.—During the Mount Everest expedition of last year Major Morshead and his plane-tablers mapped the whole country traversed on a scale of 4 miles to 1 inch, with the exception of the area within 10 miles of Mount Everest, which was surveyed photographically by Major Wheeler. On the return of the expedition this map was rapidly reproduced in colours by the Survey of India. The *Geographical Journal* for February contains a reduced reproduction on a scale of 1 : 750,000 of Major Morshead's map in outline, time being insufficient for the preparation of a hill shaded or hachured plate which has now been taken in hand. On this sheet the area around Mount Everest has not been taken from Major Wheeler's photographic survey, which did not reach London in time, but has been filled in by a map constructed at the Royal Geographical Society from panorama photographs. The positions of certain stations east and west of the mountain were resected from the few peaks the positions of which had been triangulated from the plains of India. When these stations were fixed other points could be intersected, and a framework was thus constructed on which the topography was sketched from photographs. This map is also reproduced, but on a scale of 1 : 100,000.

NEW SURVEYS IN KERGUELEN.—Considerable additions to the chart of Kerguelen were the outcome of Capt. R. Rallier du Baty's expedition in the *Curieuse* in the southern summer of 1913–14. Previous surveys of the coasts were very incomplete in many parts and little of value had been done since the visit of the *Challenger* in 1873. Capt. du Baty's work, the publication of which was delayed by the war, now appears in *La Geographie* (January 1922) in a revised large-scale chart of Kerguelen, on which many new soundings appear, and two sheets of harbour plans. Six harbours were surveyed in detail, including Port Curieuse, an unexpected discovery on the smooth storm-beaten west coast. Three other harbours were partly surveyed. The charts are admirably reproduced in colour. Some meteorological data for six months are appended to the paper.

NUCLEAR DIVISION IN OPALINA.—Prof. R. W. Hegner and Dr. Wu (*American Naturalist*, vol. 55, pp. 335–46, 1921) have analysed the relation between growth and nuclear division in the well-known multinucleate ciliate Opalina, from the frog's rectum, based on the study and measurements of 455 specimens. The investigation was undertaken with the view of affording further evidence on the nucleo-cytoplasmic relation theory, according to which an increase in the amount of cytoplasm as compared with the amount of nuclear material furnishes the stimulus which initiates nuclear division. The multinucleate condition and the absence of cell-walls make Opalina a favourable object for such study. By comparing the area of specimens in various stages with the number, size, and state of division of the nuclei the authors have been able to determine approximately the amount of increase of cytoplasm which stimulates nuclear division in Opalina. Nuclear

division in this multinucleate organism is not synchronous; one nucleus is usually stimulated to divide before the others, and this division is, for the time, sufficient to re-establish the normal relations between nuclei and cytoplasm.

VARIATIONS IN ORGANS OF AURELIA.—It has long been known that considerable variation occurs in the number of radial canals and tentaculocysts in Aurelia, but only recently has investigation been made as to whether the ephyræ produced by individual strobilæ were always normal, or, if abnormal, were similar in their abnormalities. Mr. J. W. Low has published (Proc. Roy. Phys. Soc. Edinburgh, vol. 20, pp. 226–35) an account of his observations on twenty-seven productive strobilæ, each of which was kept in sea-water in a separate vessel. The ephyræ were examined in the order in which they were produced. The largest number of ephyræ given off by one strobila was twenty-eight; the average production per strobila was about ten, and the total number of ephyræ examined was 278, of which 90 showed major or minor abnormalities. Six of the strobilæ produced only normal ephyræ having the usual eight arms and tentaculocysts, four pairs of gastric filaments, and four mouth-lappets. The remaining strobilæ produced ephyræ some or all of which exhibited departures from the normal. The same strobila may give rise to normal ephyræ and to ephyræ having more or less than the normal number of arms, and in particular cases there was found to be abrupt discontinuity, *e.g.* from a four-rayed to a twelve-rayed form. The extremes of variation were represented by three-rayed and fourteen-rayed examples.

MICROSCOPE OBJECTIVES.—The problem of improving the design of microscope objectives in the near future has been taken up seriously in the last few months, and three suggestions have been made for the more accurate measurement of the errors to which such objectives are subject. It is rightly felt that better methods of testing must be introduced before the objectives themselves can be improved. Mr. Martin at the November meeting of the Optical Society suggested a modification of the Hartman test by transmitting the beam from the objective through separate small holes in a screen; Mr. Twyman in the November number of the *Philosophical Magazine* suggested a modification of his interference method, and Dr. Hartridge in October showed to the Cambridge Philosophical Society the curves he had obtained by a third method. He restricts the beam entering the objective to a small area and determines by means of a micrometer the lateral change of position of the image of a small object. The change is reduced to unit magnification and plotted against the portion of the aperture used, expressed as a fraction of the numerical aperture of the objective. The shape of the curve obtained gives the curvature of the field, and the magnitude of the spherical and chromatic aberrations present.

TREATMENT OF SURRA IN CAMELS.—Antimony salts such as tartar emetic are frequently curative for diseases caused by protozoal and other animal parasites, *e.g.* in oriental sore and kala-azar caused by Leishmania, bilharziasis caused by a fluke (Schistosomum), etc. Capt. H. E. Cross finds that injections of tartar emetic cures camels affected with surra, a disease caused by a trypanosome. Different methods of administration were tried, and of 51 animals treated, 31 were cured (Dept. of Agriculture, Punjab, *Veter. Bull.* No. 2 of 1920).

ENZYME ACTION AND X-RAYS.—In the *Archives of Radiology and Electrotherapy* for January (No. 258) Mr. R. D. Lawrence records experiments on the effect of X-rays on enzyme action. The diastatic ferment of human blood and urine was chosen for the investigation. Radiation was performed with a Coolidge tube at 9 inches from the anticathode, with a $5\frac{1}{2}$-inch gap and unfiltered radiation at 2 milliamperes in the secondary. The radiation was carried out for from 1 minute up to 20 minutes. In no case had the radiation any effect on the enzyme action.

ANTI-OXIDATION.—During the study of the changes undergone by acrolein on long standing, it was noted by C. Moureu and C. Dufraisse that the spontaneous oxidation of this substance by an "Autoxidation" was influenced in a very marked manner by traces of impurities. Further investigation of this process (*Comptes rendus*, January 30) led to the unexpected discovery that the autoxidation of a large number of substances is prevented by the presence of certain bodies, named by the authors anti-oxidisers (*anti-oxygènes*), and this property is connected with the presence of the phenol group. Thus, the oxidation of benzaldehyde is prevented by the addition of a twenty-thousandth part of hydroquinone. Hydroquinone, pyrocatechol, and pyrogallol are especially active in preventing oxidation; ordinary phenol, resorcinol, guaiacol and the naphthols also act as anti-oxidisers, but the proportions required differ in each case. As an exception, phloroglucinol is without action, and in this connection it is recalled that phloroglucinol often reacts as a ketone. In the presence of a suitable proportion of an anti-oxidiser, furfurol remains colourless, acrolein gives no precipitate of disacryl, styrolene gives no resin on standing, linseed oil exposed in thin layers to air retains its fluidity for three years, fats (including butter) do not go rancid. Mineral substances, such as sodium sulphite and hyposulphite, are sensitive to the action of anti-oxidisers. The authors also consider the bearing of these facts on biology: phenols are fairly common in plants, generally absent in animals. It was found that the action of haemoglobin was not affected by phenolic anti-oxidisers.

THE EFFECT OF MOISTURE CONTENT UPON THE EXPANSION OF CONCRETE.—Bulletin No. 126 of the University of Illinois contains the results of a series of experiments upon the expansion of concrete carried out by Mr. T. Matsumoto, who has had some years of experience on harbour works at Formosa. The temperature coefficient of expansion of concrete is about the same as that of steel, so that these materials expand or contract together on heating or cooling. Concrete expands when it absorbs moisture and contracts when it is dried; the contraction causes stress in the concrete unless it is permitted to take place freely, and this stress appears to be not as small as is generally supposed. In reinforced concrete, the contraction may set up stresses in the steel which may reach the usually accepted working stress of steel when the reinforcement is less than 1·5 per cent. With 1 : 2 : 4 concrete and reinforcement greater than 1·5 per cent., shrinkage may produce stresses in the concrete approximating to its ultimate tensile strength, and such concrete is liable to develop cracks unless proper provision is made. The author does not consider that reinforced concrete is likely to be a durable material in places where a corrosive influence on steel, such as sea air, is active, unless proper protection against shrinkage cracks is made.

Ewing's Theory of Magnetic Induction.

AT the Royal Society of Edinburgh on February 20, Sir J. Alfred Ewing read a paper on "Models of Ferromagnetic Induction," giving a detailed account of his most recent work in magnetism.

In this paper Sir Alfred Ewing develops the theory of magnetic induction put forward by him in 1890, and discusses the reasons which have led him to modify the theory in an important particular. The theory was based on Weber's conception that a substance capable of strong magnetisation, such as iron, owes its magnetic quality to the presence within it of ultimate magnetic particles capable of being turned, and that the process of magnetising consists in compelling these particles to face more or less completely in one direction. When all the Weber particles are facing one way the iron is magnetically saturated.

What the author showed in 1890 was that the control under which the Weber particles turned was a magnetic control, and that in turning they fell over from one position of stable equilibrium to another, through an unstable phase, thereby producing the phenomena of magnetic hysteresis. This fundamental feature of the theory is retained but the author has now abandoned his further idea that the control of the particles was due simply to their mutual magnetic forces, acting from atom to atom, because a quantitative examination of the forces produced in that way has convinced him that other forces are also involved. These other forces are those which exist within each individual atom, between the Weber particle and the rest of the atom. We now know the atom to be a very complex whole, comprising many moving electrons. In a substance such as iron each atom contains a Weber particle—a thing that turns under the influence of an external magnetising force. It is not the atom as a whole that turns, but only a part of it. According to the author's view there is magnetic control exerted between the part that turns and an outer shell which is held fixed in relation to neighbouring atoms. He now shows that all the characteristics of the magnetising process can be accounted for on this basis, and may be reproduced by means of illustrative models.

FIG. 1.

The first part of the paper is a study of the equilibrium of pivoted magnets, undertaken with reference to the author's model of 1890, in which the Weber particles were represented as rows of little magnets controlling one another by their mutual forces only. It is shown that this model fails quantitatively because when the magnets are placed near enough together to give the correct form to the curve of magnetisation, in its several stages, the deflecting force which is required to break up the row is enormously greater than that which suffices to produce strong magnetisation in iron. Iron acquires only about one per cent. of its magnetism of saturation during the first or quasi-elastic stage in the deflection of the Weber particles, before irreversible turning sets in. This means that the magnets of the old model had to be set with so small a clearance between them that the stability of the row was far too great. In the new model the stability can be reduced to any desired extent, for it depends on the balance of attracting and repelling forces due to the action of opposite portions of the outer shell of the atom on the Weber particle within.

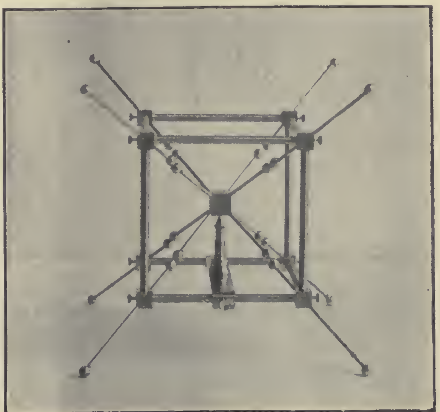

FIG. 2.

Several forms of the new model were exhibited, some with pivoted magnets to represent the Weber particles and fixed magnets to represent the controlling portions of the atomic shell. Thus in the model of Fig. 1 a pivoted magnet in the centre turns between four fixed magnets all of which present towards it poles of the same name. In the model which is shown in Fig. 2, the Weber particle is a group of eight magnetic poles, turning as a whole within a group of eight fixed magnets. The arrangement is a cubically symmetrical one appropriate to a metal such as iron, in the crystals of which the space-lattice is known to be the centred cube. In another model (Fig. 3) the Rutherford-Bohr conception of an atom with large electron orbits is realised. The orbits are represented by elliptically shaped coils with the nucleus of the atom at their

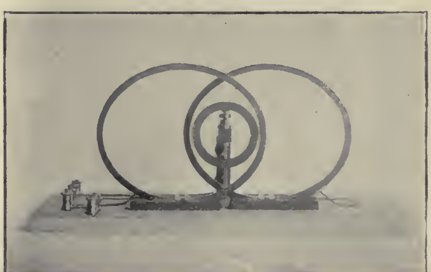

FIG. 3.

common focus: one of them is circular and turns under the control of the others, which are fixed.

Sir Alfred Ewing went on to show that with these models it is possible to imitate known features in the magnetic behaviour of metals, including effects of stress and temperature, and also effects due to the presence of non-magnetic atoms in a ferromagnetic substance, whether these were impurities or were present in combination with the metal. It was pointed out that the new model preserves all the advantages in this respect of his model of 1890 and at the same time escapes the quantitative discrepancy which had made it necessary to amend the former theory.

The Profession of Chemistry.

AT the forty-fourth annual general meeting of the Institute of Chemistry held on March 1 the president, Mr. A. Chaston Chapman, presented the first Meldola medal to Dr. Christopher Kelk Ingold. The medal, which is the gift of the Society of Maccabæans, has been instituted as a memorial to Prof. Raphael Meldola, a past-president of both the Institute and the Society, and is awarded for meritorious original work in chemistry conducted by British subjects under thirty years of age.

In the course of his presidential address Mr. Chaston Chapman said that owing to a variety of causes—foremost among which must be placed the intensive educational effect of the great war—the importance of chemistry to the national well-being was daily becoming more widely and more clearly recognised, and with that recognition had come a great development of the work of the Institute. The roll of members had increased during the past twelve months by 371 to more than 3540, and the students by 84 to 883. The organisation of the profession of chemistry was thus being steadily effected. The older members had the satisfaction of seeing the Institute placed on a sure foundation and its position as the body truly representing professional chemistry in this country, acknowledged alike by chemists, by the general public, and by the Government.

Referring to the scheme recently inaugurated under arrangements made with the Board of Education for the award of National Certificates in chemistry to students in technical schools in England and Wales, the president remarked on the advantage of bringing such students at an early age into touch with the professional qualifying body. Later, when the scheme was in operation, the council of the Institute would consider whether, and to what extent, the certificates should be allowed to rank towards the fulfilment of the conditions required for admission to the examination for the Associateship of the Institute.

In an open and comparatively young profession such as chemistry it was necessary that the public should understand clearly the nature of the work in which the members were engaged. He did not believe that any single cause had contributed so greatly to retarding in the past the progress of the profession of chemistry in this country as the misapplication of the word *chemist*. In no other country was there any confusion between the person who practised chemistry and the person who followed the profession of pharmacy, and continental chemists often expressed their inability to understand what they no doubt regarded as one of our many national peculiarities. For the present the members had to be content to express the hope that their friends the pharmacists, without relinquishing their rights, would, wherever possible, refer to their ancient, important, and very honourable calling by the word which more accurately defined and described it. The power—he might say the tyranny—of a word was often very great, and he appealed to the press, as a very important factor in the enlightenment of the general public, to assist, so far as it could, by employing the terms *chemist* and *pharmacist* respectively in the correct signification. It was to be deplored when such confusion was the unfortunate consequence of the poverty of a language; but, in this instance, the correct and distinctive words were readily available and the confusion was, therefore, easily avoidable. If chemists themselves used the word without qualifying adjectives, it would be an effective step towards establishing the proper meaning of the word.

The war had proved a very powerful factor in informing the public of the activities of the chemical profession, which occupied a position in the public esteem such as he (the president) would not have thought possible in his own lifetime; but every member should help to the best of his ability to consolidate the position they had gained, and to keep alive in the public mind the enormous national importance of the profession. Whether we regarded chemistry as a subject of study, essential to an understanding of the world in which we lived, as an agent which had done so much to transform the life of man, as one of the most powerful factors in the creation of material wealth, or, finally, as that department of natural knowledge on which our national prosperity and our national security so largely depended, its supreme importance was equally manifest.

Commenting on the production of British laboratory glassware, porcelain, and fine chemicals, the president said that the view taken by the council of the Institute and by many others who were desirous of seeing those industries firmly established in this country was that it would be a mistake of the first magnitude to revert to the position of dependence on foreign—and possibly enemy—nations. The whole chemical industry (including those essential to successful conduct of war), the prosecution of scientific research with all that it implies, and the practical teaching of science in schools and universities, all depended upon a supply of laboratory glassware, porcelain, and chemicals, adequate in quantity, suitable in quality, and reasonable in price. On national grounds, it was obviously desirable that the country should be ever directing its activities to production and to the increasing development of its internal resources. There was, moreover, the further consideration, which was much in the minds of the council, that the establishment of these essentially chemical industries demanded the services of properly qualified chemists. British manufacturers had made great progress under difficult circumstances, and there appeared to be no good reason why we should not be self-supporting in all the requirements of the profession.

After complimenting the local sections of the Institute on their activity and acknowledging the help they had given to the council in connection with the work of the Institute, the president commented on the fact that, at a time of almost unparalleled industrial depression, less than two per cent. of the members were without employment. He thought they might draw from this the comforting inference that employers were looking more and more to science to help them in overcoming technical difficulties and in improving their manufacturing operations. He concluded his address, however, with

a note of warning. Many parents still retained the impression that chemistry afforded a rapid road, if not to wealth, at least to a comfortable competence, and that it involved a less expensive course of preparation than for other professions. A keen love of the subject was essential to success; but those who were attracted to chemistry should be prepared to face a great deal of hard and often unattractive work, and to make the very real sacrifice which a professional career inevitably involved. The course of training of the average chemical student was of a university character and made the same demands upon the financial resources of parents as that for medicine and the law.

The present position of the profession should inspire its members with feelings of pride and deep satisfaction, and should stimulate them to increased endeavours to raise it still higher towards that position of pre-eminence which it was surely destined to occupy.

There was scarcely a department of human activity which was not influenced more or less profoundly by the discoveries and developments of chemistry, nor was there a single individual in the community whose comfort had not been increased and whole daily life had not been made happier—or, at least, more tolerable—through the beneficent operations of that science. What discoveries in chemistry the future might hold, and in what way those discoveries might still further modify the material life of man, none could say, but it was not unlikely that if any distinctive term should be applied by the historian of the future to the era on which we were now entering, he would describe it as the "Age of Chemistry."

Biology of Mosquitoes and the Disappearance of Malaria in Denmark.

AN interesting memoir on the biology of Danish Culicidæ has recently been completed by Dr. C. Wesenberg-Lund (Mem. Acad. Roy. Sc. et Lettres de Danemark, Section des Sciences, Series 8, vol. 7, No. 1, 1921). Forty forest-ponds were subjected to regular fortnightly exploration for some years, and from them twenty-five species have been obtained, twenty of which have been reared from larvæ. Among these are four species of Ochlerotatus known from America, but not hitherto found in Europe. Observations on the habits of the larvæ lead the author to support the general conclusion reached by other recent workers that the anal gills are best developed in those larvæ which feed at the bottom of the water. The pupæ are, as every one knows, capable of movement, but they are much more stationary than is usually believed; indeed, the author goes so far as to say that usually there is no locomotion during the whole of the pupal stage. An attempt has been made to work out the life-history of each species of Culicine from the laying of the egg onwards, and the author records many interesting observations. For instance, *Ochlerotatus communis* was found to lay its eggs singly on withered leaves or on the ground underneath these; the eggs are hatched in midwinter or early spring—many of them in April—and the imagines emerge in the first half of May. Mating takes place shortly afterwards, but the craving for blood does not arise until the latter part of June. Eggs are deposited upon dry bottoms from August to December, but do not hatch until they have passed through a period of frost. The biology of *Taeniorhynchus Richardii* also presents features of special interest; the siphon of the larva pierces the submerged roots of aquatic plants and gains access to the air in the intercellular spaces; the siphons of the pupæ are brought into close apposition at their tips and are inserted into submerged roots.

In an important concluding chapter on the three species of Anopheles—*A. plumbeus*, *bifurcatus*, and *maculipennis*, the species found also in this country—the author deals especially with the biology of *A. maculipennis*, well known as the chief carrier of malaria in Europe. He states that in Denmark this species sucks blood from domestic animals—pigs, cattle, horses—that it is seldom seen in the open, but is found, often in incredible numbers, hanging, sluggish and blood-filled, from the ceilings of pigsties, cowsheds, and stables. Only exceptionally does it suck the blood of man, whereas in Mediterranean countries it is an outdoor species feeding largely on human blood. Dr. Wesenberg-Lund considers that in Denmark *A. maculipennis*, which is there living near the northern limit of the range of the species, has ceased to be an outdoor species sucking the blood of man, and has taken to an indoor life and restricted its attacks to farm animals. In his opinion, this change in habits has been the main factor in the disappearance of malaria, the last great epidemic of which took place in Denmark in 1831.

The change in the habits of the mosquito followed an alteration in agricultural methods about a hundred years ago. Whereas previously the swine had been driven to the woods to feed on mast, they and other farm animals were thenceforward housed. The stables, etc., form so many traps which attract mosquitoes by the odour and heat of the animals within, and once within the stable the mosquitoes find all they need until the time arrives for pairing and egg-laying. Thus the connection between man and *A. maculipennis* has been broken in Denmark, and malaria was therefore bound to disappear. The author remarks that if the measurements of the length of this mosquito given by Meigen (1818), when the species presumably fed in the open and largely on man, are correct, there has been an increase in size during the intervening century, though the species is there living near the northern limit of its range.

The Unity of Anthropology.

AT the annual meeting of the Royal Anthropological Institute on January 24 the president, Dr. W. H. R. Rivers, delivered the presidential address, taking as his subject "The Unity of Anthropology."

The aim of the address was to show the unity which underlies the apparently diverse interests of the various branches of anthropology. No student of simple societies can fail to recognise this unity, for the different aspects of culture which are readily distinguished from one another in advanced civilisations are in the simple societies so intertwined and interdependent that it is hopeless to understand any one aspect without studying the whole. It is from the students of more advanced forms of human society that we need a more complete recognition of the unity of anthropology.

The unity of ethnology and archæology was illustrated by means of recent discoveries of the Rev. C. E. Fox in the Solomon Islands, where after the

bodies of the chiefs have been eviscerated they are interred within flat-topped pyramidal mounds, from the surface of which a shaft leads to the recess in which the body is placed. A dolmen is erected on the mound, by the side of which is placed an image in human form designed to receive the soul of the dead chief. These, together with other features, such as the belief in two souls, a cult of the sun with the idea of marriage with the sun, and a tradition of descent from an incestuous union, all connected especially with the chiefly clan, form a body of evidence which shows so many points of resemblance with ancient Egypt in detail that it cannot be neglected by the Egyptologist. It suggests that the rapidly increasing material provided by ethnographical research may help to elucidate some of his most difficult problems.

It was pointed out that it is only in such remote regions as Melanesia, which have not been overrun by later invasions, that we can expect to find survivals of the culture of early voyagers.

The relation between philology and ethnology was illustrated chiefly by reference to phonetics. It was pointed out that in such a region as Melanesia the philologist can now study living examples of transitions and interchanges for the existence of which in Europe his chief evidence is drawn from dead languages, impeded by the limitations which are the necessary result of fixation by means of writing. It was also shown by examples from Melanesia how features of grammar and syntax can be explained as the result of social interactions.

The present barren state of physical anthropology, in so far as it deals with living races, was ascribed to the neglect to utilise the findings of ethnology as working hypotheses and stimuli to new lines of research.

The address concluded with a consideration of the means whereby the Royal Anthropological Institute might promote the recognition of unity. It was pointed out that a scheme, already under consideration, whereby societies dealing with different aspects of human culture should be housed under one roof, with the common use of libraries and lecture-rooms, would contribute to this end; and it was suggested that the Institute itself might give much more attention than it does at present to papers and discussions which would bring out the common purpose of the more specialised studies.

Geology and the History of London.[1]

NUMEROUS small streams now "buried" under London are indicated on the new 6-in. Geological Survey Maps constructed by the author, and the historical research involved in tracing them has led to an appreciation of the connection between the geology and topography on one hand, and the original settlement and gradual growth of London on the other.

The reasons for the first selection of the site have been dealt with by several writers: below London the wide alluvial marshes formed an impassable obstacle; traffic from the Continent came by the ports of Kent, and, if destined for the north or east of Britain, sought the lowest possible crossing of the Thames. This was near old London Bridge, where the low-level gravel on the south and the Middle Terrace deposits on the north approached close to the river-bank. A settlement was obviously required here, and the northern side was chosen as the higher ground. The gravels provided a dry, healthy soil and an easily accessible water-supply; they crowned twin hills separated by the deep valley of the Walbrook, bounded on the east by the low ground near the Tower and the Lea with its marshes, and on the west by the steep descent to the Fleet; the site was, therefore, easily defensible. The river-face of the hills was, naturally, more abrupt than it is now, owing to the reclamation of ground from the river; the most ancient embankment lay 60 ft. north of the northern side of Thames Street.

The first definite evidence of a permanent settlement is the reference in Tacitus. The early Roman encampment lay east of the Walbrook, and the brick-earth on the west around St. Paul's was worked. Later the city expanded until the St. Paul's hill was included, the wall being built in the second half of the fourth century. The great Roman road from Kent (Watling Street) avoided London, and utilised the next ford upstream—at Westminster—on its way to Verulamium and the north-west. The earliest Westminster was a Roman settlement beside the ford, built on a small island of gravel and sand between two mouths of the Tyburn. This settlement could not grow, as did London, since the area of the island, known to the Saxons as Thorney, was small. The road from London to the west joined the St. Albans road at Hyde Park Corner, running along the "Strand," where the gravel came close to the river; a spring thrown out from this gravel by the London Clay was utilised for the Roman Bath in Strand Lane.

Throughout medieval times London was practically confined to the walled city, a defensible position being essential. The forests of the London-Clay belt on the north are indicated in Domesday Book and referred to by several writers, notably Fitzstephen, whose Chronicle also mentions many of the springs and wells and the marsh of Moorfields, produced largely by the damming of the Walbrook by the Wall. The same writer mentions that London and Westminster are "connected by a suburb." This was along the "Strand," and consisted first of great noblemen's houses facing the river and a row of cottages along the north side of the road; this link grew northwards, at first slowly, but in the second half of the seventeenth century with great rapidity. By the end of that period the whole of the area covered by the Middle-Terrace Gravel was built over, but the northern margin of the gravel was also that of the town for one hundred years, the London-Clay belt remaining unoccupied.

The reason for this arrested development was that the gravel provided the water-supply. In early days the City was dependent on many wells sunk through the gravel, some of which were famous, such as Clerkenwell, Holywell, and St. Clement's. In the same way the outlying hamlets (for instance, Putney, Roehampton, Clapham, Brixton, Ealing, Acton, Paddington, Kensington, Islington, etc.) started on the gravel, but later outgrew it. In the City the supply soon became inadequate, or, as Stow says, "decayed," and sundry means were adopted to supplement it. The conduit system, bringing water in pipes from distant springs, began in 1236; London Bridge Waterworks pumped water from the Thames by water-wheels from 1582 to 1817, while the New River was constructed in 1613, and is still in use. It was not until the nineteenth century that steam-pumps and iron pipes made it possible for the clay area to be occupied, thus linking together the various hamlets that now form the metropolitan boroughs of Greater London.

[1] From a lecture delivered before the Geological Society of London on February 1 by C. E. N. Bromehead.

University and Educational Intelligence.

Manchester.—Prof. H. R. Dean, having been appointed to the Chair of Bacteriology in the University of London, has resigned his appointment as Proctor Professor of Pathology.

The University Colston Society has decided to establish, with the aid of industrial firms, a number of Colston Research Fellowships in the faculties of arts, science, medicine and engineering of the University of Bristol. It is proposed to approach firms in the area served by the University with the view of obtaining support for fellowships by the payment of yearly sums of 150*l*., in return for which it would be possible for the donor to earmark the award for a particular branch of study, subject, or person, subject to the approval of the University faculty involved. These fellowships, which will be of the annual value of 150*l*., will be awarded to graduates of the University of Bristol and be tenable for one year. Should no suitable graduate of the University present himself a fellowship may be awarded to a graduate of another university or to any approved person. This scheme comes as an addition to the numerous grants which for many years past have been made by the Colston Society for the encouragement of research in the University of Bristol.

The Association of University Teachers, the president of which is Prof. J. Strong, of the University of Leeds, has issued the first number of a publication, the *University Bulletin* (6*d*.), which it is intended to produce terminally. Its primary object is to serve as the organ of the association, and an editing committee, composed of Prof. J. Strong, Mr. R. D. Laurie, and Mr. F. Smith, is in charge. In an editorial note in the issue before us it is stated that the *Bulletin* will bring to the notice of its readers the doings and policy of the council of the association, and will endeavour to foster the effort to extend the influence of the universities in the life of the nation. Other items which the first issue contains are by Sir Michael Sadler on the threefold allegiance of university teachers to their institution, to the university life of the nation and of the world; an article by Prof. Strong on the aims and activities of the Association of University Teachers; and an historical sketch by Mr. Laurie of the movement which led to the formation of the association. There are also critical notes on the University Grants Committee's Report, Parliamentary representation of teachers, superannuation for university teachers, and similar topics.

Following the lines of previous years, Mr. F. S. Marvin has arranged, in conjunction with Dr. Charles Singer, a course of lectures on "Science and Social Progress," for the Unity History School, to be held at Woodbrooke, Birmingham, from Thursday, July 27, to Friday, August 4. A sketch in broad outline will be given of the history of science, especially in its relation to the contemporary social evolution, and this will be followed, in the latter half, by discourses on the problems that are being raised to-day by the growth of science. First the historical retrospect, then the living problem, and the whole looked at from the completely human point of view. The lecturers will be Prof. J. L. Myres, Dr. J. L. E. Dreyer, Prof. J. A. Platt, Dr. C. Singer, Prof. A. N. Whitehead, Prof. C. H. Desch, Prof. J. A. Thomson, Mr. Julian Huxley, Mr. A. E. Heath, Prof. F. G. Donnan, and Mr. F. S. Marvin. Communications concerning this holiday school should be addressed to Mr. Edwin Gilbert, 78 Mutley Plain, Plymouth. All letters requiring reply should contain stamps covering the necessary postage.

Calendar of Industrial Pioneers.

March 9, 1908. Henry Clifton Sorby died.—Sorby came of an old Sheffield family of cutlers. He was of independent means. Devoting himself to scientific investigations, he became known among geologists as the father of microscopical petrology, while his microscopic study of iron and steel opened out a field of research of immense importance to the metallurgist.

March 10, 1874. Moritz Hermann Jacobi died.—German by birth, Jacobi became a professor at Dorpat and St. Petersburg, where in 1837 he discovered the art of electrotyping. He also improved the voltaic battery, and made a trial on the Neva of a boat driven by an electro motor.

March 10, 1902. Charles Yelverton O'Connor died.—An eminent civil engineer, O'Connor held important positions in New Zealand, and in 1891 became engineer-in-chief to Western Australia. He constructed the harbour at Fremantle, and was responsible for the Coolgardie Water Supply Scheme, in which water is conveyed 328 miles through 30-inch steel pipes, an undertaking costing 2,660,000*l*.

March 11, 1916. Erasmus Darwin Leavitt died.—Trained as a mechanical engineer, Leavitt served in the United States Navy during the Civil War, and afterwards as a consulting engineer was responsible for many of the most important steam-engine installations in America. He was a founder of the American Society of Mechanical Engineers, and in 1883 served as its president.

March 12, 1898. Ferdinand Hurter died.—After serving an apprenticeship to a Swiss dyer, Hurter studied chemistry under Bunsen, and in 1867 settled in England, finally becoming principal chemist to the United Alkali Company. He was a pioneer in the application of mathematics to technological chemistry; and with Driffield carried out a long and fruitful investigation of the chemistry and physics of photography.

March 12, 1914. George Westinghouse died.—A great industrialist, the president of no less than thirty companies, Westinghouse first gained a reputation by his invention of the compressed-air brake for railway trains. Tried in 1868, the brake was made automatic in 1872, and has been universally adopted. Westinghouse was a pioneer in the development of alternating current electric machinery, he assisted Tesla in his work on the induction motor, and made the first ten generators for Niagara.

March 13, 1719. Johann Friedrich Böttger died.—The discoverer of the method of making porcelain from the reddish clays found in the neighbourhood of Meissen, Böttger began life as an apothecary's apprentice in Berlin, but his discovery was largely the outcome of his alchemical experiments. For many years he was maintained as a sort of prisoner by the Elector of Dresden.

March 15, 1898. Sir Henry Bessemer died.—The greatest metallurgist of the nineteenth century, Bessemer, by the invention in 1856 of his direct process of converting pig-iron into malleable iron or mild steel, provided mankind with abundant supplies of a superior structural material at a diminished cost. Several notable metallurgists contributed to the success of the process, which reached its perfection in 1879 by the discoveries of Sidney Gilchrist Thomas.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, March 2.—Sir Charles Sherrington, president, in the chair.—L. N. G. **Filon** and H. T. **Jessop**: On the stress-optical effect in transparent solids strained beyond the elastic limit. The stress-optical effect in glass under simple pressure exhibits no time-effect at ordinary temperatures, but in celluloid under simple tension there is a marked creep in both stress-optical effect and strain even under very moderate loads. The observations can be explained on the assumption that celluloid consists of a mixture of two constituents having different elastic and plastic properties and different stress-optical coefficients, the optical-effect in each being strictly proportional to the stress.—W. E. **Curtis**: The structure of the band spectrum of helium. Measurements of grating photographs of three of the principal helium bands show that the chief features of their structure are accounted for by the quantum theory of band spectra. In each of the three bands a new type of series is found. The spectrum is considered to be due to an unstable helium molecule, having a moment of inertia of about $1 \cdot 8 \times 10^{-40}$ gm.cm.^{2}.—S. **Datta**: The spectrum of beryllium fluoride. The spectrum of beryllium fluoride consists of six groups of bands, all in the ultra-violet between λ 2800 and λ 3400, and all fading off towards the red. The strongest band at λ 3009 includes three series of lines, which depart considerably from the usual type of formula. The groups of bands are similar to one of the groups given by magnesium fluoride.—W. G. **Palmer**: The catalytic activity of copper. Pt. III. The effect upon the catalytic (dehydrogenating) activity of copper of adding to the metal varying proportions of weak dehydrogenating catalysts, ferric, manganous, zinc, and magnesium oxides, is described. Magnesium and manganous oxides enhance the activity of the copper, if present in quantity greater than 1 to 2 per cent., while zinc and ferric oxides reduce the activity. It is considered that small proportions of oxide (less than 1 to 2 per cent.) destroy the activity of the copper, owing to solution in the metal leading to diminished adsorption of the alcohol attacked.—G. B. **Jeffery**: (1) The motion of ellipsoidal particles immersed in a viscous fluid. (2) The rotation of two circular cylinders in a viscous fluid. (1) Einstein has shown that the viscosity of a fluid containing solid spherical particles in suspension is given by $\mu\ (1+2 \cdot 5\ V)$, where μ is the viscosity of the pure fluid and V is the total volume of the particles per unit volume of the suspension. This result is extended to ellipsoidal particles and it is shown that the factor 2·5 is *reduced* but always lies between 2 and 2·5 and depends upon the shape of the particles. (2) The problem of the rotation of a circular cylinder in a fluid contained in a non-concentric cylindrical vessel which may itself rotate about its axis can be solved in finite terms; that of the rotation of two parallel cylinders in an infinite fluid is in general insoluble; *i.e.* there is no steady motion for which the fluid is at rest at infinity.

PARIS.

Academy of Sciences, February 13.—M. Emile Bertin in the chair.—Maurice **Janet**: The characters of the moduli of forms and systems of partial differential equations.—Witold **Wilkosz**: A fundamental point in the theory of potential.—E. **Cartan**: A geometrical definition of the energy tensor of Einstein.—M. **Auric**: The resolution of an indeterminate linear equation.—V. **Dolejsek**: The Kα lines of the lighter elements. The Kα lines have been measured for thirteen elements, ranging between chlorine and zinc.—A. **Dauvillier**: The complexity of the K series of the light elements and its theoretical interpretation. Results and details of measurements in the K series of copper and molybdenum.—C. E. **Guye**: The extension of the law of Paschen to polarised fluids.—M. **Mercier**: Harmonic synchronisation of electrical oscillators.—R. **Bouloch**: Calculation of the elements which determine a centred system formed by any number of surfaces.—A. **Zimmern**: The influence of temperature on the sensibility of emulsions in radiography. Over the range 15° to 80° C. the sensibility of a photographic plate to light varies slightly, if at all. With X-rays, on the other hand, the sensibility increases with rise of temperature, and this effect can in some cases be utilised with advantage. It would appear that the actions of light and X-rays on the silver salt are dissimilar.—C. **Matignon** and M. **Fréjacques**: The transformation of ammonia into urea. Quantitative study of the conversion of ammonium carbamate into urea, alone or in presence of catalysts.—Paul **Pascal**: The magneto-chemical investigation of constitution in mineral chemistry. The phosphoric acids. Measurements of the magnetic susceptibilities are given, and constants deduced for the groups, P, PO_2, PO_3, PO, and PO_4. The results agree with the rational formulæ $PO(OH)_3$ and $RPO(OH)_2$ for the phosphonic and phosphoric acids, and are opposed to $H_2PO(OH)$ for hypophosphorous acid and $HPO(OH)_2$ for phosphorous acid.—E. **Decarrière**: The *rôle* of gaseous impurities in the catalytic oxidation of ammonia. The influence of hydrogen phosphide. Phosphoretted hydrogen poisons the catalyst (platinum) in ammonia oxidation, even in a proportion as low as 0·00002 per cent.—Marcel **Godehot** and Pierre **Bédos**: The oxide of cyclohexene and ortho-methylcyclohexanol. The ether oxide of cyclohexanol is obtained in quantitative yield by the oxidation of cyclohexene with perbenzoic acid. Methylmagnesium iodide reacts with the ether oxide giving *o*-methylcyclohexanol.—V. **Thomas**: A mixed organometallic compound of aluminium. Methylene iodide reacts slowly with aluminium at the ordinary temperature, no gas being evolved.—Alphonse **Mailhe**: A new preparation of amino-naphthenes. Cyclohexanone or its alkyl derivatives are converted into ketazines by reaction with hydrazine hydrate and these reduced to amines by catalytic reduction with nickel. The main product consists of primary amines, with a small proportion of secondary amines as a bye-product.—G. **Meunier**: The action of mineral acids on crude celluloses: the formation and destruction of reducing substances. The utilisation of the bye-products of this destruction. Dilute mineral acids at a high temperature attack the ligno-celluloses as vigorously as strong acids, used cold, with economy of acid. The bye-products include fatty acids, furfurol, acetone, and methyl alcohol, and suggestions are made for their utilisation.—Charles **Jacob**: The structure of southern Tonkin. Except for small differences in detail, the geological structure of southern Tonkin is the same as that of North Annam.—Mlle. Yvonne **Boisse de Black**: Rissian erosion in the high valleys of the Cère and the Goul (Cantal).—P. **Monnet**: The Italian earthquake of September 7, 1920. A slight shock on September 6 was followed on the 7th by a disastrous earthquake by reason of which 250 lives were lost. The seismic zone is a rough oval the major axis of which is S.E.–N.W. and about 50 kilometres long.—C. and M. **Schlumberger**: Electrical phenomena produced by metallic deposits. It has been shown in an earlier communication that deposits of pyrites produce spontaneously differences of potential with the surrounding layers. The

phenomenon appears to be general and the presence of pyrites is not indispensable, similar effects being traced to the presence of galena, mispickel, sulphides of copper, pyrolusite, and other minerals. The effect can be reproduced in the laboratory.—Paul **Guérin**: The mucilage of the Urticaceæ. Mucilage is widely distributed in this order, and its presence in the various organs of these plants constitutes a character of real value, and should be taken into account along with other anatomical peculiarities.—H. **Jumelle**: The Neophloga, Madagascan palm trees.—A. **Guilliermond** and G. **Mangenot**: The signification of Holmgren's canals.—Eugène **Bonnet**: The action of soluble salts of lead on plants. The plants studied included wheat, peas, and beans, and the lead solution surrounding the rootlet between one-thousandth normal and half that amount of lead. Lead arrests the growth of the stem and diminishes the length of the roots.—Gabriel **Bertrand** and Mme. M. **Rosenblatt**: The variations in the proportions of manganese in leaves with age.—Gustave **Rivière** and Georges **Pichard**: The partial sterilisation of the soil. Experiments on the use of sodium arsenate for the partial sterilisation of the soil. Used in the proportion of between 21 and 42 kilograms per hectare the protozoa are destroyed and the useful bacteria multiply. This indirect fertilising action is shown by increased yields, which on the large scale have been shown to be 20 per cent. to 50 per cent.—Auguste **Lumière** and Henri **Couturier**: The resistance of females during pregnancy to anaphylactic and anaphylactoid shock. Female guinea-pigs during pregnancy are immune from shock caused either by the injection of serum or of flocculent inert material. The cause of the immunity has been traced to the increase in the volume of the blood: the immunity could be destroyed in females by bleeding and conferred on males by injecting physiological serum.—M. **Champy**: The conditions of the genesis of the sexual harmozone in Batrachians.—Henri Jean **Frossard**: Respiratory gymnastics and the tests of Valsalva and of Muller.—Foveau de **Courmelles**: Combined radiotherapy of the breast and the ovaries against tumours of the breast.

Official Publications Received.

Meddelanden från Statens Skogsförsöksanstalt. Hälfte 18, Nr. 4: Stamforms-Undersökningar en Sammanfattande Analys av Norrländskt Tallmaterial med Avseende på de Faktorer som Bestämma Noggrannheten vid Aptering på Rot. (Stem Form Investigations: Accuracy of Yield Estimation of Standing Trees.) By Sven Petrini. Pp. 165-220. Hälfte 18, Nr. 5: Till Kannedomen om Förhallåndet mellan Solbladens och Skuggbladens Kolhydratsproduktion. By M. G. Stålfelt. Pp. 221-280. Hälfte 18, Nr. 6-9: Skogsinsekternas Skadegorelse under 1918, die Beschädigungen der Forstinsekten im Jahre 1918. By Ivar Trägårdh. Bidrag Till Kännedomen om Splintborrarnas Näringsgnag: Beitrag zur Kenntnis des Ernährungsfrasses bei den europäischen Splintkäfern. By Paul Spessivtseff. Årsberättelser 1920. Årsberättelser 1921. Pp. 281-352. (Stockholm.)

I.—1922. Ceylon. Report of the Industries Commission. Pp. 91. (Colombo: Government Record Office.) 2.75 rupees.

Nigeria. Annual Report on the Forest Administration for the Year 1920 and period 1st January to 31st March 1921. Pp. 24. (Ibadan: Forestry Department.)

Bulletin of the American Museum of Natural History. Vol. 45. I.: On the Distribution of the Ants of the Ethiopian and Malagasy Regions. By Wm. M. Wheeler. II.: The Ants collected by the American Museum Congo Expedition. By Wm. M. Wheeler. Pp. 13-269+plates 2-23. (New York.)

U.S. Department of Agriculture: Bureau of Biological Survey. North American Fauna, No. 45: A Biological Survey of Alabama. By Arthur H. Howell. 1: Physiography and Life Zones. 2: The Mammals. Pp. 88+11 plates. (Washington: Government Printing Office.)

The Carnegie Foundation for the Advancement of Teaching. Sixteenth Annual Report of the President and of the Treasurer. Pp. vi+205. (New York City.)

Hydro-Electric Survey of India. Vol. 3: Triennial Report, with a Preliminary Forecast of the Water Power Resources of India, 1919 to 1921. By J. W. Meares. Pp. ix+199. (Calcutta: Government Printing Office.) 4 rupees.

Ministry of Agriculture, Egypt. Report on the Motor Tractor Trials organized by the Ministry of Agriculture. Part A: At Kafr Bata—December 1920. Part B: At Damanhur—April 1921. Pp. iv+55+plates. (Cairo: Government Press.) P.T. 15.

Department of Agriculture, Mysore. Mysore Agricultural Calendar 1922. Pp. iii+56. (Bangalore: Government Press.) 1 anna.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Lucia, 1920. Pp. iv+28. (Barbados.) 6*d*.

Trinidad and Tobago. Council Paper No. 100 of 1921. Department of Agriculture. Administration Reports of the Director of Agriculture for the Years 1919 and 1920. Pp. 84. (Port of Spain: Government Printing Office.) 2*s*. 3*d*.

Department of the Interior: Bureau of Education. Bulletin, 1920, No. 39: Facilities for Foreign Students in American Colleges and Universities. By Samuel P. Capen. Pp. 269. (Washington: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 459: Surface Water Supply of the United States, 1917. Part IX.: Colorado River Basin. Pp. 192+xxxiii. Water-Supply Paper 460: Surface Water Supply of the United States, 1917. Part X.: The Great Basin. Pp. 277+xl. Water-Supply Paper 475: Surface Water Supply of the United States, 1918. Part V.: Hudson Bay and Upper Mississippi River Basins. Pp. 153+xxx. (Washington: Government Printing Office.)

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures, and Condition of the Institution for the Year ending June 30, 1919. (Publication 2590.) Pp. xii+557. (Washington.)

Diary of Societies.

FRIDAY, March 10.

Royal Astronomical Society, at 5.
Physical Society of London (at Imperial College of Science and Technology), at 5.—R. L. Smith-Rose: The Electromagnetic Screening of a Triode Oscillator.—Dr. H. P. Waran: A New Form of High Vacuum Automatic Mercury Pump.—W. N. Bond: Viscosity Determination by means of Orifices and Short Tubes.
Malacological Society of London (at Linnean Society).
Royal Society of Medicine (Clinical Section), at 5.30.—Prof. H. Maclean and Dr. I. Jones: Some Observations on the Production of Lactic Acid in Stomach Diseases.
Junior Institution of Engineers, at 8.—C. H. Plant: Friction.
Royal Society of Medicine (Ophthalmology Section), at 8.30.—P. G. Doyne: Coloured Vision.—R. A. Greeves: A Series of Sympathising Eyes examined Microscopically.
Royal Institution of Great Britain, at 9.—Prof. T. R. Merton: Problems in the Variability of Spectra.

SATURDAY, March 11.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: Radioactivity (2).

MONDAY, March 13.

Royal Geographical Society (at Lowther Lodge, Kensington Gore, S.W.7), at 5.—C. C. Fagg: A Description of the Regional Survey of the Croydon Natural History and Scientific Society.
Royal Society of Medicine (War Section), at 5.30.—Squadron Leader H. E. Whittingham: Observations on Sandfly Fever in Malta.
Institute of Transport (at Institution of Civil Engineers), at 5.30.—T. R. Johnson: Railway Problems in China and Australia.
Medical Society of London (at 11 Chandos Street, W.1), at 8.—Dr. E. W. Goodall: The Differential Diagnosis of the Common Exanthemata.

TUESDAY, March 14.

Royal Institution of Great Britain, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire. Series I. Racial Problems in Asia and Australasia (4).
Royal Society of Medicine (Therapeutics and Pharmacology Section) (at University College), at 4.30.
Eugenics Education Society (at Royal Society), at 5.—H. Cox: The Reduction of the Birth Rate as a Necessary Instrument for the Improvement of the Race.
Royal College of Physicians of London, at 5.—Dr. M. Greenwood: The Influence of Industrial Employment on General Health (Milroy Lectures) (2).
Royal Sanitary Institute (90 Buckingham Palace Road, S.W.1), at 5.30.—A. H. Barker, and others: Central Heating in Relation to Domestic and other Buildings.
Women's Engineering Society (at 26 George Street, W.1), at 6.15.—F. S. Button: Women's Place in Industry.
Institution of Petroleum Technologists (at Royal Society of Arts), at 6.30.—Prof. J. S. S. Brame: Presidential Address.
Royal Photographic Society of Great Britain, at 7.—Annual General Meeting.
Quekett Microscopical Club, at 7.30.—B. S. Curwen: Mounting in Glycerine with Wax Seals, with Special Reference to Entomostraca.
Royal Anthropological Institute, at 8.15.—J. P. Mills: The Lhota Nagas.
Royal Society of Medicine (Psychiatry Section), at 8.30.—Adjourned Discussion on the Ideal Clinic for Nervous and Borderland Cases.

WEDNESDAY, March 15.

Royal Society of Medicine (History of Medicine Section), at 5.—F. Romer: A Short History of Bonesetting.
Institution of Civil Engineers (Students' Meeting), at 6.—G. FitzGibbon: The Great Ship-Canals of the World (Vernon Harcourt Lectures) (1).
Royal Meteorological Society, at 7.30.—Dr. E. M. Wedderburn: Seiches; and the effect of Wind and Atmospheric Pressure on Inland Lakes.

ROYAL SOCIETY OF ARTS, at 8.—O. T. Falk: Certain Aspects of the Problem of Exchange Stabilisation.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.
ROYAL MICROSCOPICAL SOCIETY, at 8.—J. E. Barnard: The Future of the Microscope in Medical Research.—Dr. H. Hartridge: Monochromatic Illumination. A Low-Power Eyepiece with Large Field.

THURSDAY, MARCH 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. P. C. Mitchell: The Cinema as a Zoological Method (1).
ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Dr. H. H. Dale and C. H. Kellaway: Anaphylaxis and Anaphylatoxins.—J. C. Bramwell and Prof. A. V. Hill: The Velocity of the Pulse Wave in Man.—A. Fleming: A New Bacteriolytic Element found in Tissues and Secretions.—Dr. J. W. Pickering and Dr. J. A. Hewitt: The Action of "Peptone" on Blood and Immunity thereto.
LINNEAN SOCIETY OF LONDON, at 5.—B. M. Griffiths: The Heleoplankton of Three Berkshire Pools.—C. E. Salmon: Three British Plants.—Rev. F. C. R. Jourdain: Bear Island and Spitzbergen, with especial regard to their Bird-life.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. M. Greenwood: The Influence of Industrial Employment on General Health (3).
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Dr. V. E. Pullin: Radiological Examination of Materials.
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—L. C. Stuckey: Notes on the Valuation of Ores, Concentrates and Smelter Products.—L. H. Cooke: Methods of Measuring Horizontal Angles involving Steep or Precipitous Sights.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. G. Hill: Phantom Telephone Circuits and Combined Telegraph and Telephone Circuits worked at Audio Frequencies.
CHEMICAL SOCIETY, at 8.—H. B. Baker: Change of Properties of Substances on Drying.—H. Burton and J. Kenner: The Influence of Nitro-Groups on the Reactivity of Substituents in the Benzene Nucleus. Part VI. The Elimination of Halogen during the Reduction of Halogenated Nitro-Compounds.
SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, W.C.2), at 8.—Open Meeting.
ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 8.30.—Dr. J. Darier: Des cancers épithéliaux de la peau.

FRIDAY, MARCH 17.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.
INSTITUTE OF TRANSPORT (at Royal Society of Arts), at 5.—F. Pick: The Operation of an Omnibus Company, with reference to Capacity and Cost under Given Conditions.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—P. C. Dewhurst: British and American Locomotive Design and Practice.
INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—C. C. H. Wade: The Electron Theory.
JUNIOR INSTITUTION OF ENGINEERS, at 8.—G. H. Ayres: Power Factor Improvement.
ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. M. Legge and others: Discussion on the Pathological Changes produced in Subjects rendered Unconscious by Electric Shock, and the Treatment.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Principal A. P. Laurie: The Pigments and Mediums of the Old Masters.

SATURDAY, MARCH 18.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (3).
PHYSIOLOGICAL SOCIETY (at University College).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

FRIDAY, MARCH 10.

METEOROLOGICAL OFFICE (South Kensington, S.W.7), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (8).
TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. C. Miller: The New Psychology and its Bearing on Education (7).

SATURDAY, MARCH 11.

LONDON DAY TRAINING COLLEGE, at 11.—Prof. J. Adams: The School Class (8).
HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Cleopatra's Needle and Sun-worship.

TUESDAY, MARCH 14.

IMPERIAL COLLEGE (Royal School of Mines), at 5.30.—Col. N. T. Belalew: The Crystallisation of Metals (4).

WEDNESDAY, MARCH 15.

EAST LONDON COLLEGE, at 4.—Prof. F. E. Fritch: Certain Aspects of Freshwater Algal Biology (5).
LONDON (R.F.H.) SCHOOL OF MEDICINE FOR WOMEN (Hunter Street, W.C.1), at 5.—Dr. H. H. Dale: Some Recent Developments in Pharmacology (4).
KING'S COLLEGE, at 5.15.—Prof. N. Bohr: The Quantum Theory of Radiation and the Constitution of the Atom (2).
HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (8).
UNIVERSITY COLLEGE, at 8.—The Current Work of the Biometric and Eugenics Laboratories (5). Julia Bell: The Inheritance of certain Types of Blindness.

THURSDAY, MARCH 16.

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. L. D. Barnett: The Hindu Culture of India (3).
UNIVERSITY COLLEGE, at 5.15.—Prof. J. E. G. de Montmorency: Welsh and Irish Tribal Customs (6).
KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (9).
LONDON DAY TRAINING COLLEGE, at 6.—Dr. W. Rosenhain: Aluminium and its Alloys.

FRIDAY, MARCH 17.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (9).
KING'S COLLEGE, at 5.—Prof. R. Robinson: Orientation and Conjugation in Organic Chemistry from the Standpoint of the Theories of Partial Valency and of Latent Polarity of Atoms (3).
TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. C. Miller: The New Psychology and its Bearing on Education (8).

SATURDAY, MARCH 18.

THE POLYTECHNIC (Regent Street, W.1), at 10.30 A.M.—P. A. Best: The Romance of Commerce.
HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: The Natural History of Elephants.

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The Melbourne University Bill.

MELBOURNE University early took high rank among the universities of the British Dominions by the special distinction of many of its staff, the high standard of its degrees, and the harmonious co-operation between it and its affiliated colleges. There has, however, been a feeling in recent years among educationists in Victoria that the university is not still of the same standing, as it had not kept pace with progress elsewhere. To remove the causes of any such decline the Government of Victoria has introduced a Bill raising the statutory grant to the university from 21,000*l.* per annum to 30,000*l.*, the amount stated as necessary by the university council. This Bill also proposes reforms in the constitution of the university.

The ultimate authority at present is the senate, which consists of all the graduates of the university holding the degree of doctor or master. This body has some legislative powers and elects practically the whole of the university council, which is the executive and administrative organ of the university. To give such authority to the senate was probably the soundest policy available at the foundation of the university, but it is no longer necessary. The new Bill therefore proposes to replace the senate by a convocation which would consist of all the graduates, would act through a committee, and would elect twelve out of the thirty members of the council. The Bill reconstitutes the council to make it more widely representative. The new council would consist of thirty members, seven appointed by the Government, two by the university staff, and one by the students, and would include the director of education and the president of the Professorial Board *ex officio*. These members and the twelve elected by convocation would co-opt the six remaining members.

The new Bill assigns to the university three additional branches of work, a school of commerce, research at the university in applied science, and a university extension department; and it allots for these purposes an extra grant of 7000*l.* per annum. The allocation to the university of the proposed educational extension work would seem to be to its advantage as well as to that of the State. There is a widespread reaction towards various forms of affiliation as a means of widening the influence of universities on national education; but this system often imposes a severe burden on a university, and is better not employed if some other way of organising higher provincial education be available. In the case of Victoria, failing the scheme proposed in the Bill, the alternatives are the organisation of super-secondary classes by the Education Department, or the award of university degrees to external students by examination, the course recently adopted in Western Australia and Queensland. The proposal in the Bill for the admission of fifty free students a year to the university would therefore seem to be to its ultimate benefit, by lessening any claim for affiliation that might be put forward in future by provincial institutions.

The lines of the new Bill follow the present general trend of university reform. The University Association of Teachers, of which Prof. W. A. Osborne, the president of the Professorial Board, is chairman, has, however, issued a statement expressing great anxiety and disappointment at some of its features. The criticisms complain especially of the inadequate representation of the university staff on the new council, and of the disregard of the principle that a university should not be called upon to undertake new duties until the old duties are properly provided for. The statement points out that the 9000*l.* added to the annual grant for general university purposes would be so reduced by new expenses and loss of revenue from fees and public examinations that the university would gain at the utmost only an extra 1200*l.* If these estimates be correct, this additional income is obviously quite insufficient to enable the university to cope with the inrush of new students, who increased in numbers from 1296 in 1914 to 2607 in 1921.

This criticism is less against the Government than against the university council, which, according to the Association of University Teachers, has failed to protect the interests of the university by not raising fees and by asking for an inadequate increase of the State grant. The Government has given the amount

said to be necessary, and has probably under-estimated the effects on the university income of some of the proposed changes. If these effects be demonstrated, the raising of the general university grant may be expected.

The discussion of the new Bill shows that university teachers in Australia are profoundly anxious as to the present conditions, are doubtful of the possibility of maintaining the university work at an appropriate level, and are alarmed at the discontent rife among all grades of the staff. It is impossible for any one not intimately acquainted with existing conditions in Australia to judge the financial estimates, but it is obvious that if a university staff is thoroughly discontented its efficiency is bound to suffer. Teachers who are not paid a living wage must supplement their income by outside work which, except perhaps in departments of applied science, inevitably detracts from their usefulness to the university.

Those interested in the progress of the universities of the British Empire will hope that the Victorian Government, before the new Bill is passed, will allay the distracting anxieties of the university staff by making sure that the nominal increase of 30 per cent. in the general purposes grant is an actual increase of this amount, and by amending the regulations relating to the council so as to guarantee a larger representation of university teachers. The provision that one of the six members to be co-opted by the council and two of the twelve to be elected by convocation must be university teachers would give a staff representation of one in five, which is the average in the younger British universities. If by such changes the new scheme gained the confidence of the staff the reforms would restrengthen the university, which has hitherto been a glory to the State of Victoria and an important asset in the development of Australia.

Greek Mathematics.

A History of Greek Mathematics. By Sir Thomas Heath. Vol. 1, *From Thales to Euclid*. Pp. xv +446. Vol. 2, *From Aristarchus to Diophantus*. Pp. xi+586. (Oxford: Clarendon Press, 1921.) 2 vols., 50*s*. net.

WERE this book only for the mathematician it would be no book for me; but it is a great deal more. It is for all who care for the historical aspect of science; it is for all lovers of Greek, for mathematics is a true "Legacy of Greece," and is interwoven through and through with Greek thought and philosophy.

A couple of accidents in boyhood (if I may be allowed the reminiscence) made this subject curiously attractive to me. George Johnston Allman, pioneer in this country of the renewed study of Greek geometry, belonged to the little band of scholarly professors who taught in those days in Galway College; he had more of mathematics and more of fine historic sense than of Greek letters, and here his colleagues—"Tom" Maguire the Platonist, Davies the editor of the *Eumenides*, and my father, who was his kinsman—combined to help him. In our quiet Galway life we heard for months together little else than of Allman's book and the long discussions which went to the making of it.

About the same time I had for schoolmaster in Edinburgh (and long after for a close friend) Dr. John Sturgeon Mackay, as deeply versed in Greek mathematics as Allman himself. In Edinburgh he was scarcely known save to his schoolboys, and lived a life as neglected as that still greater Hellenist Veitch (of the "Greek Verbs") had done; but he spent his vacations reading Greek MSS. in the great libraries, and in Paris he was intimate with Paul Tannery and the scholars of the day. Mackay's life-task was to edit Pappus, the one great Alexandrine omitted by the Oxford editors of the eighteenth century. After twenty years' work the thing was done, and lay in his desk with every diagram exquisitely drawn and every page and footnote written and rewritten. He went one day into Williams and Norgate's bookshop, then in Edinburgh, and the manager said: "I have something that will interest you to-day, Dr. Mackay"; and he handed him the first volume, fresh from Leipzig, of Hultsch's edition of Pappus. The two men must (as Mackay told me afterwards) have been following one another unawares from library to library, collating the same MSS., noting the same minute textual details, and Mackay's intimacy with the French had helped doubtless, in those long-ago post-war years, to keep him unacquainted with the German and his work. Anyway, there was an end of the matter. Some might have hurried into print, trusting to little points of their own, claiming something of the reward—but not Mackay. The work was done and well done. Pappus was edited. It was a scholar's tragedy—and nothing more!

Sir Thomas Heath has produced one important work after another, while living all the while a life of strenuous official toil and responsibility. His Diophantus, his Apollonius, and (greatest perhaps of all) his Euclid are part of the solid foundation of this "History of Greek Mathematics." He has had more to build on by a long way than Allman and Gow had fifty years ago; new texts have been edited, and men like Heiberg, Tannery, Zeuthen, Aldo Mieli, and (last but not least) Gino Loria have dealt with the matter in part and

whole; but the essential difficulty remains of piecing together the broken stones.

In our first glimpse of ancient mathematics two great figures, Pythagoras and Plato, stand out above all the rest: not as the greatest mathematicians, but as the greatest landmarks in history and tradition, much like Descartes and Leibniz in another age. From Plato on, the story runs fairly smooth; we leave tradition behind and enter upon history; mathematics becomes a science of its own and slowly disentangles itself from philosophy; the "polymath" is giving place to the specialist. With Euclid we enter on the "Golden Age" of geometry cradled in Plato's Academy, and though some of the minor men (like Nicomedes and Diocles) remain shadowy figures, we have a solid inheritance in Euclid and Apollonius and in Archimedes—"ordine quidem tertius" (as Torelli said), "dignitate facile princeps." On the physical side the astronomy of Eudoxus, the Optics of Euclid, the astronomy again of Aristarchus—the "Copernicus of antiquity"—may be taken as "nails in a sure place"; and when we come to the "Silver Age" of Diophantus, Pappus, Ptolemy and Theon, we have a wealth of historical material.

But up to Plato's time it is a very different story, for the simple reason that very few of the earlier philosophers and mathematicians (say down to Archytas) ever *wrote* at all. Their teaching was private or even secret, and only oral tradition carried it on. Two things men will continue to discuss but never know for sure—the debt the first Greek mathematicians owed to Egypt and the East, and the real, actual attainments in mathematics of men like Thales, Pythagoras, Archytas, Democritus and Plato. Pythagoras is the strangest case of all, for no wise man's name since Solomon's has so fascinated the world. Tradition, and tradition alone, tells us that he invented the forty-seventh proposition, and tells it no more confidently than the Dancing Dervishes of Constantinople tell you they are the descendants of his holy Brotherhood!

Where there is nothing but tradition to go upon, the historian is lost. The imaginative man begins putting two and two together, arguing what *must* have been known in order to know this or that, and what *must* have followed as soon as this or that was understood; and so the story grows. The construction of the Pentagon "must" have implied a knowledge of the Golden Section, and this and the "Theorem" itself must have involved the concept of the Irrational; the triangle of the Pentalpha and its gnomons must have led on to the logarithmic spiral—even to the Limaçon of Pascal! In some such way Naber, for instance, discourses on what Pythagoras "must" have known and what he may have known; it is pleasant, even suggestive, reading, but it is a long, long way from history. At the other end stand the sceptical critics, to be taken more seriously—like Eva Sachs, whose book, by the way, on "Die fünf platonischen Körper," Heath does not seem to quote. She, for example, holds that up to Philolaus we know nothing at all; that he and later Pythagoreans were chiefly bent on ascribing each new thing to the old master of their school; that there is no proof that Pythagoras knew anything of irrationals, little that he was acquainted with the regular solids, and none at all that he associated them, *more Platonico*, with a theory of the Elements. Between such opinions Sir Thomas Heath steers a careful middle course, and what he has to tell he attributes to "the Pythagoreans" rather than to Pythagoras.

Again, as to alien sources behind early Greek mathematics, one school will tell you that Greece had nothing or next to nothing to gain from the land-surveyors or "rope-stretchers" of Egypt, nor from Mesopotamian astronomers and calendar-makers. Others eagerly pick up little stray hints of a community or descent of ancient learning. They remind us that it was in Ionia that Greek philosophy arose and the special sciences, even medicine, began—in a "mélange de races d'émigrés, d'origine diverse," as Heiberg called the Ionians the other day; that Ionia was in close and constant touch with Lydia; and that Ionian science appeared after a clash of empires and fall of cities, as a later Renaissance followed the fall of Constantinople. Or they catch hold of straws which point, or seem to point, to Far Eastern intercourse, such (for instance) as that mode of reckoning by myriads and myriads of myriads which the Japanese are said to have used about the time (say) of Thales, which exists in China to this day, and seems identical with Archimedes' famous numeration of the *Arenarius*—where he began by supposing a myriad grains of sand in the space of a poppy-seed (or rather surely a poppy-*head*), and went on to myriad-myriads of units, and of orders, and of periods. Heath discusses the broad question briefly and fairly, and is content in the end to agree (as we all must) with Plato, that whatsoever the Greeks had borrowed, were it much or little, they it was who improved on it and carried it towards perfection. The Greeks at least knew well what not to borrow, and striking above all else is their choice of themes. It is they who best exemplify what Sir John Herschel laid down (perhaps rightly) as a general proposition—that men delight to escape from the trammels of earth: that not practical problems but "the abstractions of geometry, the properties of numbers, the movements of the celestial spheres, whatsoever is abstruse, remote and extramundane, become the first objects of infant

science." The useful applications, mechanical inventions, follow later on; and David Hume put it neatly when he remarked that "we cannot reasonably expect a piece of woollen cloth to be brought to perfection in a nation that is ignorant of astronomy."

Two things attract the general student, I think, more than any others connected with Greek mathematics—the Pythagorean arithmetic and the matter of the Platonic bodies. The former begins with the notion, characteristically Greek rather than peculiarly Pythagorean or Platonic, of arithmetic as something apart from mere calculation or the doing of sums—as, in short, a "theory of numbers"; and not the least curious thing about it is that that arithmetic was studied (or so it is said) for generations before the Greeks had signs, even alphabetic ones, for the numerals. We may go to Sir Thomas Heath for a clear and full account of all the curious sorts of numbers, figurate and other, odd and even, square, triangular, and pyramidal, friendly numbers, perfect numbers, and so forth, which fertile imagination along with true mathematical insight was able to discover. It is not without a deep meaning, I believe, that we find on the very threshold of Mathematics this instinct for the symmetry of numbers, this sense of the intrinsic beauty, the comparative perfection, of one number or another. It is the way the calculating boy begins; we had it exemplified in the highest degree, only the other day, in Ramanujan's extraordinary but too short-lived talent. The theme, in Greek hands, leads on and on by many roads. By way of the "means," it is at the root of the theory of music itself, of the "acousmatic" side of the Pythagorean philosophy; by the theory of "gnomons" it is close-linked with the "theorem" of Pythagoras; it carries us, though more in contrast than identity, to the Euclidean treatment of arithmetic; and at last it brings us straight to the Neo-pythagoreans, to the "Theologumena," and to later writers down even to Kircher, who dealt more and more extravagantly (much after the fashion of the Cabbala) "de abditis numerorum mysteriis"—with the physical, the "ethical" and the "theological" properties of numbers.

The other matter, that of the Platonic bodies, is a long story. We know that Plato did not discover them but we may still be curious to know whether Pythagoras did; and here we must distinguish the mathematical side of the question from the physico-philosophical one—from the deeper meaning which Plato and others found in these five symmetries. It has been amply shown, I think, that their association with the elements was not due to Pythagoras, and it is not likely that Pythagoras knew very much even about their construction and properties. To suppose him to have understood these is to credit him with too much; the main teaching of Euclid would have been already his: "Le cadre était déjà celui," as Tannery says, "que remplissait les Eléments [d'Euclide]." But who were the great mathematicians who investigated them? Theætetus was probably the outstanding man—he who "*described*," that is *constructed*, the five solids, according to Suidas—though Heath hesitates (curiously) over the meaning of ἔγραψε. Heath quotes also the Euclid-scholion that Theaetetus added the octahedron and icosahedron to the other three, but I do not think he mentions that this has (or so it might seem) a textual flaw; for surely the octahedron was as old as the Pyramids, while the *dodecahedron* would be one of the last, probably the last of all, to be constructed and explained. Plato, then, may have taken his mathematics in this matter from Theaetetus, partly (some would say) from Democritus, and something more straight from Leucippus. So with their help was built up Plato's theory, fanciful no doubt but very beautiful, of these five figures, all inscribable in spheres, not really solids but hollow shells with filmy surfaces, made out of tiny triangles—as the gold-beater begins with little three-sided patins of gold—the figures being, as it were, molecules with the facets for atoms, and the whole forming a sort of foamy, cellular structure, like a froth of soap-bubbles, out of which to build the material of an harmonious world. Indeed, one wonders whether Plato had not in his mind's eye the homely but exquisite configuration of a froth of soap-suds!

The theme is kindred to our last. For just as an arithmetic grew up regardless of practical reckoning and dealing only with the symmetrical properties of numbers, so did a geometry arise which thought nothing of practical mensuration, only of the abstract properties, the essential symmetries, of planes and solids. This geometry, which studied the triangle, the square, the pentagon, etc., then the "Platonic" and "Archimedean" bodies, the regular and semi-regular solids, the perfect, the less perfect and the imperfect geometrical forms, was own sister to that arithmetic which investigated the triangles, squares, polygons, pyramids and cubes, the "perfections and imperfections," which lie hidden among the mysterious properties of numbers. And all the while these theoretical studies of *configuration* were being applied along somewhat narrow but very important lines to music, to optics and to astronomy, as we should say to problems of sound, light and periodic motion—in short, to the three great recognised groups of harmonious natural phenomena. This, then, in a word, was the concept of Greek mathematics as it occupied the wit of man, the intellect of philosophers, for just a thousand years.

The Archimedean bodies, by the way, Heath deals with pretty fully, but he might perhaps have told us that one of these (Kepler's "truncated octahedron"), said to have been known to Plato, is no other than that tetrakaidekahedron which Lord Kelvin showed to be (with a slight modification) the typical "cell" of a homogeneous froth. He might even perhaps have told us a little of how Kepler (true disciple of Pythagoras and of Plato) used both Platonic and Archimedean bodies in that treasure-house of elegant geometry, the "Harmonice Mundi"; and how he showed that not only the five Platonic bodies (as Euclid knew) but also Archimedes' thirteen were all there are, the complete series of their respective families.

There is a vast deal of information in Heath's book, clearly set forth and orderly arranged; we have nothing to compare with it in English, and Gino Loria's "Scienze esatte" is its only serious rival abroad. I am inclined to think that Loria paints history with a broader brush, while Heath excels in his account of individual mathematicians; but I cannot help thinking that Heath, who has attained such complete and acknowledged success in his editions of Euclid and the rest, must have found that in this history he had struck a harder task than any he had tried before. We may know more of the history of mathematics than of any other science, but the lacunæ are immense, and tradition is poor material for the historian. Moreover the historical aspect is somewhat uncongenial to the mathematician, if only because (as Eva Sachs says) history deals with *das Werden*, and mathematics with *das Sein*!

When Sir Thomas Heath deals with Euclid, Apollonius, Archimedes, Diophantus, Hero or Pappus, he gives us in a few pages all we could expect by way of epitome of the trend, the method and the results of their labours. But his book pursues its steady, instructive course with little digression, allusion or anecdote, and with curiously little bibliographical information such as he puts abundantly into his other books. Surely one of the objects of a text-book is to guide the student to what it does not and cannot contain! Some of us, I think, would have liked a little more digression or even gossip. When Sir Thomas has told us that the Pentalpha was the Pythagorean symbol of Health he is well-nigh done; but Chasles gives us a dozen pages of learned gossip upon it, traces it through Boetius and Thomas Bradwardine and the Margarita Philosophica and Father Kircher to Kepler himself, and ends with Poinssot's "Mémoire sur les Polygones"! The Shoemaker's Knife is a beautiful and simple construction in easy geometry, of great antiquity—an ancient proposition, Pappus calls it—and Heath tells us doubtless all that is essential for us to know; but a short footnote might have told us how Jacob Steiner investigated and elaborated it, or how J. S. Mackay epitomised its many properties, or how Sir Thomas Muir added a pretty corollary.

Again (as a random instance) Heath discusses at length the simple but important rule of Thymaridas (simplicity itself in our notation) for solving certain simultaneous equations, where the sum of $x_1+x_2+\ \ldots\ x_n$ is known, and also the successive sums of x_1+x_2, x_1+x_3, etc.; but of Thymaridas he only tells us that he was "an ancient Pythagorean, probably not later than Plato's time." If we be limited to a phrase I do not know that we could say a safer thing; but why should we not have some little sign-post, even a footnote, to Tannery's discussion (in "L'Arithmétique pythagorienne") on who Thymaridas was and when he lived, or to the many discussions by Cantor, Martin, Nesselmann, and even Fabricius; for "il y a un assez grand intérêt historique à déterminer l'âge où vivait Thymaridas." Heath tells us that this rule of his was called by the special name of ἐπάνθημα, and he translates it "the 'flower' or 'bloom' of Thymaridas." He qualifies this by a parenthetic remark that the name was not, after all, confined to this particular proposition, but what it really means he does not explain; Tannery, I think, has shown fairly clearly that it was a name ("pour ainsi dire") "pour les matières non exigées du programme de l'arithmétique pour les étudiants en philosophie."

It was again Thymaridas who defined (as Heath tells us) "a unit as 'limiting quantity,'" περαίνουσα ποσότης. It was a very important definition, but was it not a definition of "unity" rather than of "a unit," and is a limiting *quantity* a fair and full translation of ποσότης? Turn towards the other end of the volume, to ground that is peculiarly Heath's own, and see Euclid's famous definition (V. 3) of *ratio*, which Heath renders "a sort of relation in respect of *size* (πηλικότης) between two magnitudes of the same kind." I cannot help thinking that, between the two, we lose the fine and even crucial distinction between ποσότης and πηλικότης. The one mathematician was talking of a relation between numbers, the other of a ratio between any two magnitudes; I think they both picked their words accordingly, and I should like at least to give them the benefit of the doubt. Of Euclid's definition Heath tells us that "it was probably inserted for completeness' sake, and in order merely to aid the conception of a ratio." All the same, I should rather like to hear what Barrow had to say of its metaphysical character; or what an older school meant when they translated

πηλικότης by *quantuplicity*; or even to be referred to that very curious imaginary discussion of this very point, by Euclid, Eutocius, Theon and the rest, in the pages of Meibom's "De Proportionibus." The simple fact is that Sir Thomas Heath has given us so much, and it is all so good, that he makes us ask for more.

D'ARCY W. THOMPSON.

Entomology and Malaria.

The Prevention of Malaria in the Federated Malay States: A Record of Twenty Years' Progress. By Dr. Malcolm Watson, with contributions by P. S. Hunter and A. R. Wellington. Second edition, revised and enlarged. Pp. xxviii + 381. (London: John Murray, 1921.) 36*s*. net.

DR. WATSON'S book shows clearly the wide range of scientific knowledge which is required by those who work in the tropics either as physicians or as sanitarians. It is unnecessary nowadays to insist upon the importance of the control of malaria in the development of those vast areas from which is derived so much of the food supplies and raw materials of manufacture of all civilised countries, but only those who have had practical experience of the methods used to deal with the disease can appreciate how many and how varied these must be.

Until about the middle of the nineteenth century medical men were almost always naturalists as well, and it is regrettable that the old traditional association of medicine and natural science has been so largely broken off. In modern times the older teaching of natural history has been replaced by an inadequate course of so-called biology which may, indeed, enable the student to recognise the appendages of the cockroach, or a section of the rhizome of a fern, but scarcely qualifies him to name correctly the commonest insect or plant when he sees it in the field. The need for a more practical knowledge of the forms and bionomics of animals, and especially of insects, is brought home to one again and again during the perusal of Dr. Watson's very interesting and readable book.

It was indeed no light task which confronted the author when in 1901 he began his service in the Malay States. The new knowledge of the mode of transmission of malaria by certain mosquitoes had to find a practical application in a country where physical conditions are very diversified and little or nothing was known about the insect carriers. Large commercial interests, too, were involved, and no doubt there were many interested persons ready to criticise adversely any failure, and reluctant to spend money on what they regarded as the doctor's theories. Here were the most favourable conditions imaginable for mosquitoes—an equable, warm, and moist climate; a large rainfall almost equally distributed throughout the year; abundance of pools, swamps, and hill-streams. As to the prevalence of mosquitoes, Dr. Watson relates that, in a small patch of jungle in the town of Klang, *Anopheles umbrosus*, a natural carrier of malaria, was present in such large numbers that three persons caught about two hundred in a quarter of an hour "and simply could not stand the biting any longer." At the same time, three other species of mosquitoes were present "in considerably greater numbers than the anopheline, so it can be imagined a quarter of an hour in that jungle was unpleasant."

FIG. 1.—Kapar Drainage Scheme. One of the main drains, with rubber-trees on both sides. From "The Prevention of Malaria in the Federated Malay States."

The book abounds with interesting details concerning the natural history of various mosquitoes, and shows how necessary such knowledge is before any attempt can be made to mitigate the malarial scourge. The case of *Anopheles Ludlowi* is a good vindication—if any were needed—of the practical importance of the taxonomic work of the systematic entomologist. There are three species, *A. Ludlowi, A. Rossii,* and *A. indefinitus,* so similar to one another that the experience of an expert is required to distinguish between them. Yet of these three only one, *A. Ludlowi,* is known to be a natural carrier of malaria. Moreover, it differs entirely from the others in its habits, breeding mainly along the coast and often in brackish water. In connection with this mosquito Dr. Watson gives a good account of the mangrove-swamps, and explains how engineering works on the coast may cause an increase of malaria by interference with the tidal flushing of the swamps.

As the prevalent mosquitoes vary in the plains and in the hills, so the methods of dealing with malaria differ in each locality. As the jungle is cleared and drained in the plains malaria disappears; whilst in the hills drainage and the opening up of the jungle alone fail to influence the prevalence of the disease. The explanation of this is that in the plains the mosquito which carries malaria is *Anopheles umbrosus,* which breeds in pools in the jungle; in the hills the mosquito chiefly concerned is *A. maculatus,* the breeding-place of which is the running water of springs and hill-streams. A method which may be quite successful in diminishing the numbers of one species may yet fail to lessen the incidence of malaria, since it may lead to conditions suitable for the breeding of another species. How all these different problems were dealt with satisfactorily will be found in the volume under review.

The book appeals to other than medical men. Many interesting sidelights are thrown on the inhabitants, on life in the Malay States, and on the development of rubber planting; a good account also is given of the physical features of the country, with its mangrove-swamps, "flat land," coastal and inland hills.

The book is written in an attractive style, and such a large amount of knowledge is so pleasantly and modestly displayed that it will certainly add much to the high reputation of the authors; and, since the methods for the prevention of malaria, which were used so successfully in the Malay States, are of general application, this lucid account will be of the utmost value to all medical men practising in tropical and subtropical regions. The book is well printed and illustrated by a large number of excellent photographs, two of which are here reproduced.

H. J. WALTON.

FIG. 2.—The end of the subsoil pipes in a ravine on the Seafield Estate; from this point the water continues in an open drain. Photograph taken in dry weather. From "The Prevention of Malaria in the Federated Malay States."

Berber Surgery and Sport in the Aurès Mountains.

(1) *Among the Hill Folk of Algeria: Journeys among the Shawia of the Aurès Mountains.* By M. W. Hilton-Simpson. Pp. 248. (London: T. Fisher Unwin, Ltd., 1921.) 21*s.* net.

(2) *Shooting Trips in Europe and Algeria: Being a Record of Sport in the Alps, Pyrenees, Norway, Sweden, Corsica, and Algeria.* By H. P. Highton. Pp. 237. (London: H. F. and G. Witherby, 1921.) 16*s.*

(1) THE gregarious nature of the British tourist is illustrated by Captain Hilton-Simpson's claim that during his excursions among the Algerian hills near Biskra, which he describes as one of the most popular tourist resorts of the whole world, his wife was the first European woman to be seen by many of the people of the adjacent hills. His journeys in the mountains of Aurès, the Mons Aurasius of the Romans, were conducted mainly to study the native surgery and make a collection of the instruments used for the Pitt-Rivers Museum, Oxford. The most valuable chapter in his book is the account of Berber surgery, which is not easily studied, as the French apply to the Northern Sahara the law that a fatal operation conducted by a man who is not medically qualified is manslaughter. Captain Hilton-Simpson, by gifts of drugs and surgical instruments, was able to gain the confidence of some of the native practitioners. He secured admission to some operations, and has collected much interesting information as to the methods of treatment. The most remarkable success is in trepanning.

The author has made seventeen visits to Algeria, so he knows the country well, and his book is a valuable record of contemporary native life in the remoter villages of the Southern Atlas. He refers to indications of a greater rainfall at the time of the Roman occupation, though the general evidence given in the book indicates that the climate in Roman times was much the same as it is to-day.

(2) The same district has been described from a very different point of view by Mr. H. P. Highton, a science master at Rugby. He, also, discarding the ways of the ordinary tourist, has devoted many of the generous holidays allowed at the public schools to shooting trips, in one of which he visited the mountains of Southern Algeria in quest of the Barbary sheep and the Dorcas gazelle. Other journeys were in chase of chamois in the Alps and the Pyrenees, of elk and reindeer in Norway and Sweden, and of moufflon in Corsica. Chamois-hunting he calls the prince of sport. His narratives are brightly written. He concludes with a defence of shooting based on the nature-red-in-tooth-and-claw principle, and the claim that, though animals suffer greatly from mental anguish when chased, as presumably in fox-hunting, they feel little physical pain. This line of argument is almost the opposite to that adopted by Roosevelt, based on the quickness with which wild animals forget sudden alarm.

The War and the Royal Engineers.

The Work of the Royal Engineers in the European War, 1914–19.

(1) *Water Supply.* Part I.: *General Development of Organization, Plant, and Works.* Pp. 54 + 32 pls. + 2 maps. Part II.: *Operations.* Pp. 55-92 + 9 pls. + 8 maps.

(2) *Bridging.* Pp. 87 + 33 pls. + 3 maps.

(3) *Supply of Engineer Stores and Equipment.* Pp. 109.

(4) *The Signal Service in the European War of 1914 to 1918. (France.)* By R. E. Priestley. Pp. xvi + 359 + 20 pls.

(Chatham: Secretary, R.E. Institute; W. and J. Mackay and Co., Ltd., 1921.)

(1) IN the last year of the war operations involving "concentrations of unexampled density could be successfully undertaken at short notice in any areas, and at the points most desirable for strategical or tactical reasons, without reference to the presence of water in or near the surface." The ways and means by which this result was achieved are well set forth in the work under review. Amongst them may be mentioned the erection of semi-permanent and extensive supply systems with head works and pipe-lines, such as those at Roosbrugghe, the free use of mechanical transport, and the extensive use of boring plant. Drills were used on a small scale in the chalk area in 1915, the air-lift pump soon giving a great impetus to boring operations. Portable air-compressor plants mounted on lorries visited a borehole and worked so long as was necessary to fill the local storage plants.

Scarcely less important than the supply of water was the purification of it, and full details of the methods used are given. Large purification plants did excellent work of a pioneer nature in supplying potable water from canals—in some cases through pipe-lines several miles in length.

(2) The need for heavy bridges was first experienced on the Aisne. From that time the history of bridging during the war was determined largely by the increasingly important rôle played by the heavy artillery and tanks, the maximum axle load to be carried rising from thirteen to thirty tons. With the aid of drawings and some excellent photographs, the various standard

types of bridges evolved in the campaign are passed under review. One of the most remarkable types, from the point of view of lightness and ease of erection, was the Inglis bridge of identical bays of weldless steel tubes.

The chapter on temporary bridges is a really stirring account of typical bridging operations during the final advance of August to November, 1918. A succession of waterways had to be forced before each serious engagement. In one case a field company erected a trestle bridge of 80-ft. span within 500 yds. of the enemy line, completing it four hours before the attack was launched. No fewer than 539 heavy bridges were erected between August and November, 1918.

(3) The supply of stores necessarily developed not only in quantity, but also in variety, for "it came about that the R.E. were early regarded as the universal providers of everything that was not authorised equipment." By March 1919, more than 1,800,000 tons of R.E. stores of the most diverse nature had been sent over to the Western front. Road metal, camouflage, electric-light installations, and propaganda balloons, all figured in the lists. Constantly increasing experimental work on new devices was also carried out, and the statement of the results achieved is of considerable interest.

(4) This study of the nervous system of the Army in the recent war is the story of a service constantly "struggling with ever fresh developments and responsibilities: sometimes failing, more often succeeding, and always improving and learning." The need for continual adjustment of ideas and nimbleness of thought on the part of those directing the policy of signals has not ended with the war. Just as "the discovery of the magneto telephone by the General Staff was probably responsible for a revolution in staff methods as great as any that has ever occurred in the history of war," so may the developments of wireless telegraphy and telephony bring many new problems for the signal officer of the future. While recognising fully the strangle-hold that code and cipher exercised on the use of wireless during the greater part of the war, Major Priestley points out how, as shelling and bombing became more intense, wireless forced its way more and more into use and recognition. It is clearly his view that the signals of the future will be mainly wireless supported by line telegraphy and visual work.

Few remarks throw more light on the extent to which signals grew in complexity during the war and technical qualifications came to be required by front-line troops than the statement that at the end of the war, the battalion and battery signaller was expected to have more qualifications than those possessed by the line telegraphists of the Royal Engineers at the commencement of the war.

For its system of hastily improvising a large army this country paid the penalty that must needs accompany such a process. Had we been better organised to make full use of man-power and brain-power on a national emergency, Moseley could scarcely have been allowed to go to his gallant death at Gallipoli. He could have been so much more profitably employed in his corps either in developing wireless or in examining and combating the overhearing of telephone signals. Our slowness in the recognition of enemy overhearing, with all the unnecessary loss of life that it involved, is a natural sequel to our general unpreparedness for the great emergency of 1914.

Granted that we were not always first in the field in the early days of the war, we can, however, recognise fairly that lost time was well made up before the end. The close of the war found the Signal Service "efficient in its day and generation, as the *personnel* of the highly trained units of the original Expeditionary Force had been in theirs."

Our Bookshelf.

Nut Growing. By R. T. Morris. Pp. x+236. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1921.) 13*s*. net.

There is little of the dry manual about this useful volume. The author has a "message" to give to a world seeking new foodstuffs, and though he occupies forty pages in introducing the subject, his preliminary remarks are to the point and well worth reading by those interested. Briefly, the book is a practical guide to the commercial cultivation of trees bearing edible nuts, and is addressed to growers in America, where in recent years much attention has been given to this industry. The nuts dealt with include hickories, walnuts, hazels, chestnuts, pine nuts, and almonds. Reference is made to the devastation caused in the forests of American chestnut (*Castanea dentata*) by the fungus *Endothia parasitica*, which threatens to destroy the species unless resistant stocks can be discovered and successfully propagated. The author claims to have produced hybrids between this tree and the chinkapin (*Castanea pumila*) which are highly resistant to the fungus, and bear nuts of good size and quality. An important section on propagation deals with the practical aspects of nut cultivation, and has been written mainly with the object of describing a special system of grafting, which is clearly illustrated in a series of excellent plates.

A Handbook on Cotton and Tobacco Cultivation in Nyasaland: A Guide to Prospective Settlers. By J. S. J. McCall. Pp. 85. (Zomba, Nyasaland: The Government Printer, 1920.)

It is greatly to be regretted that the late Mr. McCall did not long survive his promotion from the post of

Director of Agriculture in Nyasaland to the corresponding directorship in the newly acquired Tanganyika Territory. His little book is a useful summary of practical information on cotton and tobacco growing in Nyasaland, and contains just those particulars which experience shows are required by would-be planters with little or no previous knowledge of these crops.

The greater part of the book is devoted to cotton, a crop of which Mr. McCall had much experience. Nyasaland long-staple cotton has gained a high reputation and finds a ready market. A controlling factor in production is transport, and on this point the author expresses the view that "the progress of cotton growing in Africa to-day depends more than ever on railways and mechanical transport. The cultivation of tobacco has become one of the most important planting industries of the Protectorate, and the leaf (Virginian type) is well known in this country. The information given regarding the growing and curing of this crop forms a useful first guide to a subject requiring careful study.

A Popular Chemical Dictionary: A Compendious Encyclopaedia. By C. T. Kingzett. Second edition. Pp. viii+539. (London: Baillière, Tindall and Cox, 1921.) 21*s.* net.

THE first edition of this useful book has been exhausted in less than one year, thus proving that it filled a vacancy in chemical literature. A careful perusal of the new edition shows that much new material has been added which enhances considerably the utility of the book. In particular the chief constants of most of the chemicals named have been added, and the work now forms a handy and popular book of reference embracing in one moderately sized volume a mass of up-to-date information on practically every branch of chemistry and allied sciences.

The information is imparted in a clear and interesting manner, freed so far as possible from technicalities. Consequently any one wishing to ascertain the meaning of a term or definition, or the nature of any material or subject in the scope of chemistry or mineralogy, will find without difficulty and within a few seconds the information required—information which is often difficult to lay hands on immediately when embedded in the pages of a large text-book.

G. M.

The Adjustment and Testing of Telescope Objectives. Third edition. Pp. 123+3 plates. (York and London: T. Cooke and Sons, Ltd., 1921.)

THIS volume is the third edition of a book first published in 1891. The favourable reception accorded to the earlier editions, and the extent of their circulation, have encouraged the publishers to re-issue the work with the amplifications necessary to bring it up to date.

The book deals with the simplest and most effective means of detecting flaws in telescope objectives, as well as the various maladjustments and imperfections of mounting, which may prevent an observer from obtaining the best results from his telescope. Different types of objective are treated separately, a special section being devoted to the Cooke triple photo-visual objective. The points to which attention is given include squaring-on, achromatism, astigmatism, spherical and zonal aberration, mechanical strains, and other smaller, but equally important, matters. There is also a short chapter on the general treatment of objectives. The volume concludes with reprints of three papers by Mr. H. Dennis Taylor, originally presented to the Royal Astronomical Society, dealing with achromatism and the secondary colour aberrations of refractors.

The book is very clearly written, and should prove of great use, not only in detecting faults in imperfect objectives, but also in enabling an observer to determine whether defects in star images are due to the objective or to the manner of its setting. It should appeal especially to the amateur astronomer possessing a small refractor. The directions for testing and adjustment are of the simplest possible character, and involve keen observation rather than mechanical skill.

The publishers have done a great service to astronomy in preparing such a useful little book.

Bibliographia Agrogeologica: Essay of a Systematic Bibliography of Agro-Geology. By Adolf Wulff. (Mededeelingen van de Landbouwhoogeschool en van de Daaraan Verbonden Instituten, Deel 20.) Pp. iv+285. (Wageningen: H. Veenman, 1921.) 4·50 florins.

THE study of the soil has developed so rapidly in recent years that no student can keep pace with the output of papers, nor can the best card index of an individual worker be relied upon as being complete. The necessity for such adventitious aid as is afforded by a bibliography has long become pressing, and this is now supplied by Dr. Adolf Wulff. No fewer than 3300 titles are given, the papers being drawn from more than 600 journals, and the list goes up to November 1, 1919. A satisfactory classification is adopted, so that the student will have no difficulty in finding his way through the bibliography even if he has to consult it only occasionally.

Although the title suggests to English ears only the geological or mineralogical side, the index covers the whole ground dealt with in this country by soil investigators, including soil organisms, soil organic matter, and the relations of soil to the growing plant. The English is remarkably free from errors, and the few misprints will cause no difficulty.

Prof. J. van Baren contributes an interesting discussion on soil problems, bringing together a considerable amount of work which is little known, and forming a useful introduction to the whole volume. Altogether the book is one which can safely be recommended to students and investigators in the subject.

E. J. R.

Patents and Chemical Research. By H. E. Potts. Pp. x+198. (Liverpool: University Press, 1921.) 8*s.* 6*d.* net.

A PATENT, like any other form of contract, depends very largely for its value upon the skill with which it has been drawn up. The form of wording, in fact, may be quite as important as the subject-matter.

Particularly is this so in the case of a patent for a chemical invention, where the scope of the monopoly must be defined in chemical terms and generally without reference to drawings. Clearly, then, it is to the advantage of the patentee to obtain the fullest legal co-operation in drafting the specification for a chemical invention.

Mr. Potts makes this his theme, and in the major portion of his book he develops it by laying down the principles upon which to construct a chemical patent that will procure maximum protection consistent with security against possible infringement or invalidation. His observations should be distinctly helpful both to the research worker in industrial chemistry and to the patent agent, though they tend perhaps to exaggerate a little the function of the latter. Whether, for instance, the patent expert would be capable of diagnosing chemical problems to the extent indicated in chap. 3 is rather open to doubt.

But there can be no question of the author's grasp of the fundamentals of patent law; the discrimination with which he has selected his leading cases when discussing the validity of patents demonstrates this. On the business aspect of patents, too, the author's views are well worthy of attention, especially as regards their value, individually and collectively, in commercial warfare. E. J.

Astronomical Photography for Amateurs. By H. H. Waters. Pp. iv + 93 + v plates. (London: Gall and Inglis, n.d.) 6*s.* net.

AMATEURS possessing small telescopes may, with the means at their disposal, secure good astronomical photographs, and the volume under notice is an elementary handbook intended to explain in a simple manner how good results may be achieved. The book does not go beyond this stage, so that none of the many uses to which astronomical photographs may be put are touched upon.

It is to be regretted that the amateur's share in photographic methods of observation should be regarded as being confined solely to obtaining pictorial records. But, even accepting this limitation, there is much that the amateur may do with telescopes of small aperture. As an instance of what can be accomplished with a small instrument in the hands of a skilled observer, it may be mentioned that many of Prof. Barnard's superb photographs of the Milky Way were secured with a small lens of less than 2-in. aperture. To amateurs desirous of attempting something in this direction, but hesitating through lack of experience and for want of a guide, this book can be recommended. It is written by one who has had some success in this field, and is full of practical hints and directions as to the methods of working, the type of camera necessary, and the exposures and apertures most suitable for photographing various objects. This is just the sort of book which a beginner requires. It includes five plates with reproductions of astronomical photographs obtained by the author. These are printed on a paper of poor quality, with the result that they are practically useless as indications to the beginner of the results which he should be able to obtain. H. S. J.

Philosophy and the New Physics: An Essay on the Relativity Theory and the Theory of Quanta. By Prof. L. Rougier. Authorised translation from the author's corrected text of "La Matérialisation de l'Energie" by Prof. M. Masius. Pp. vi + 159. (Philadelphia: P. Blakiston's Son and Co., 1921.)

La Matière et l'Energie: Selon la Théorie de la Relativité et la Théorie des Quanta. Par Prof. L. Rougier. Nouvelle édition, revue et augmentée. Pp. xii + 112. (Paris: Gauthier-Villars et Cie, 1921.) 9.50 francs.

THE French title is a better indication than the English of the contents of this little book. The only philosophical question discussed at any length is that of the relation between matter and energy, regarded as an extreme example of the fundamental problem of a substance and its properties. By far the greater part of the space is devoted to a simple exposition of the theory of relativity and the quantum theory, which is as well suited for those whose interests are primarily scientific as for philosophers. The exposition is quite adequate, but it is not superior to all others of the same scope. The author has not solved the insoluble problem of giving a true account of mathematical theories without assuming familiarity with the mathematical ideas from which they derive their value and meaning; but he has succeeded in avoiding the distortion of meaning that is frequently a result of such attempts. We can recommend the book to any one with philosophical inclinations who wants to make one more attempt to "understand Einstein," but we are not sure that it was worth translation. However, the translator has done his work, except in the title, with unusual competence.

Personal Beauty and Racial Betterment. By Prof. Knight Dunlap. Pp. 95. (London: Henry Kimpton, 1920.) 6*s.* net.

PROF. DUNLAP'S essay on racial betterment consists of two parts. In the first he analyses the elements which go to make up the ideal of personal beauty as a basis of sexual selection; in the second he deals with its conservation as a means to the improvement of the race. Personal beauty, he maintains, on the negative side is the absence of deformity and of deviation from the accepted type towards that of an inferior race, while on the positive side it is the sign and expression of the *potentiality* of the individual, not in his own interests, but in the interests of the species. Prof. Dunlap meets possible objections that his view of the factors making for racial betterment is entirely physical by maintaining that that is the primary ideal essential for "the attainment of ultimate ideals." This is somewhat vague, but apparently he means that mental and moral qualities may be neglected in sexual selection without detriment—a somewhat large assumption. He discusses the question of the unfit and the desirability in their case of sterilisation, as well as the various causes operative in checking the fertility of those who are best fitted to perpetuate the race. Though he maintains that some fundamental reform is necessary and cannot long be delayed, he himself has no practical programme to propose.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of rejected manuscripts intended for this, or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Magnetic Model of Atomic Constitution.

THE following preliminary description of a new magnetic model atom is given on account of the remarkable coincidence between the results we have obtained experimentally and the views which Dr. Aston has put forward with regard to the atomic constitution of certain of the lower elements.

An attempt has already been made by Sir J. J. Thomson to draw a parallel between atomic structure and the arrangements into which Mayer's magnets group themselves; but this parallelism suffered from the fundamental flaw that there was no numerical relationship between the strength of the central pole and the united strengths of the floating magnets. In order to have a true parallel, it is essential that the strength of the central pole should increase *pari passu* with the number of magnets afloat at one time; for only in this way can a "magnetic neutrality" be obtained which will represent the electrical neutrality of the atom.

In our preliminary work we achieved a close approximation to this state of affairs by using a series of equal magnets. A single magnet was fixed vertically at the bottom of a lead tank filled with water, above the surface of which a second vertical magnet was held in a glass tube. On the water surface, a third vertical magnet was floated by means of a cork disk. All the magnets had their north poles upward. Since both poles of a floating magnet repel those of another floating magnet, it is necessary to have two fixed magnets for each floating one, in order to establish neutrality. When two floats are in the dish, two magnets are placed at the bottom and two magnets in the glass tube, and so on. In this way, the strength of the central pole is always exactly equal and opposite to the combined powers of the floating magnets.

When this arrangement is tested with numbers of floating magnets corresponding to units of atomic weight in the various elements, the following results are obtained. The magnets arrange themselves into two sharply defined and clearly separated groups, the central one of which may for convenience be termed the nucleus, whilst the second group may be named the ring. In the table below are the experimental results showing the distribution of the magnets into the two groups:—

Magnets.	In Nucleus.	Total minus Nucleus.	Corresponds to
1	1	0	Hydrogen.
4	2	2	Helium.
6	3	3	Lithium-6.
7	4	3	Lithium-7.
9	5	4	Beryllium.
10	5	5	Boron-10.
11	6	5	Boron-11.
12	6	6	Carbon.
14	7	7	Nitrogen.
16	8	8	Oxygen.
19	10	9	Fluorine.
20	10	10	Neon.

Inspection will show that this series of groupings corresponds exactly to the suggestions put forward by Dr. Aston. He regards each unit of atomic weight as a proton carrying one positive charge; and the atomic number of the element is, as Prof. Soddy suggested, the algebraic sum of the positive and negative charges in the atomic nucleus. In the new atomic model, it will be seen, the systems arrange themselves spontaneously so as to form a perfect analogy to the hypothetical atomic structures. Thus in the case of Boron-10 the central pole contains ten magnets; five of these are "neutralised" by the five floating magnets of the nucleus, leaving a net "charge" of five, which is the atomic number of boron. In the case of Boron-11 there are eleven magnets in the central pole; six floating magnets "neutralise" six of them, leaving free five—the atomic number of both isotopic forms of boron.

All the known elements and isotopes in the series find their exact parallel in these magnetic models; and the coincidence, if it be merely coincidence, is certainly surprising.

It should be pointed out that hydrogen is anomalous, since obviously a single magnet cannot simultaneously form part of two groupings, nucleus and ring. If the floating magnet in this case be reckoned as a ring magnet instead of a nuclear one, then hydrogen would have the atomic number 1.

It seems worth while to point out that the number of magnets in the ring is always equal to the maximum valency of the element plus two units; and the occurrence of two magnets in the ring of the system corresponding to helium suggests that all the eight elements up to fluorine are built up with two residual non-detachable electrons in the ring. In the case of neon, the non-detachables evidently number 10; and this suggests a connection with the Rydberg series $2(1^2+2^2+2^2+3^2\ .\ .\ .)$, which evidently has some connection with atomic structure.

It appeared of interest to examine the cases of the atomic weights 2, 3, 5, and 8, which have at present no corresponding elements. With two floating magnets, one forms the nucleus and the other the ring group, which gives an atomic number 1. This substance would therefore by analogy be an isotope of hydrogen with an atomic weight 2. With three magnets, one again forms the nucleus, with two others in the ring: this corresponds to the atomic number 2, so that the element, if it exists at all, may be an isotope of helium. Five magnets give a system of two in the nucleus and three in the ring—an isotope of lithium. In the case of eight magnets there are two possible groupings, almost equally stable. Four in the nucleus and four in the ring would correspond to an isotope of beryllium. Five in the nucleus and three outside is the analogue of a fourth lithium isotope. These two groupings would be isobaric systems.

It would occupy too much space to discuss the regularities of the magnetic groupings within the nucleus, but one point of interest may be mentioned. In the case of Boron-11 and carbon, both nuclei contain six magnets arranged in two pairs of concentric triangles. In view of the general resemblance in physical characteristics between boron and carbon, and especially of the fact that in its hydrides boron is quadrivalent like carbon (yielding B_2H_6 like C_2H_6 and not BH_3 as might be expected from its position in Group III.), this peculiarity seems not without meaning.

We propose to extend this investigation immediately with improved apparatus which we hope will surmount some of the obvious experimental difficulties in the case of more complex systems.

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Nature of Vowel Sounds.

THE following observations as to the nature of the vowel sounds of a single voice (my own)—details of which form the subject of a separate communication to the journal of the International Phonetic Association—may be of interest.

The sounds were observed by ear, first, for the whispered vowels, and afterwards with a larynx note superimposed. In the whispered series it was found that each of the separate vowels was characterised by *two* resonant notes, an upper component ranging from about ♯d″ (608~) to e‴ (2579~), and a lower component ranging from ♯d′ (304~) to ♯a″ (912~).

The upper components are produced in a manner analogous to that of whistled notes, and their pitch is mainly controlled by the distance of the tongue from the palate and teeth. The same note may be produced with almost any degree of opening of the mouth; about one octave of the scale can be produced—through the nose—with the mouth closed altogether. These notes, for convenience, are referred to as "whistle notes."

The lower components appear to depend, like the pitch of a Helmholtz resonator, largely on the area of the mouth opening—they are referred to as resonator notes.

The two series are independent of each other, so that, for example, an ascending scale of resonator notes and a descending scale of whistle notes may be produced (whispered) simultaneously.

The characteristic whistle and resonator notes for each vowel sound are not absolutely fixed (for an individual voice), but may vary in some cases over as much as 5 semitones without loss of the vowel characteristic.

The ranges of "neighbouring" vowels often overlap, so that two different vowels may have the same whistle or resonator note, but in such cases the other component will be substantially different.

In one or two cases, such as "ii" (eat) and "i" (it) the ranges of *both* components overlap, and the difference between these vowels may be produced in some cases mainly by difference of stress.

When a larynx note is added—as in singing or talking—the pitch of the resonator note does not appear to be affected at all by variations of pitch of the larynx note.

The whistle notes generally are not affected, so long as the pitch of the whistle note in question differs sufficiently widely—say by 2 to 3 octaves—from that of the larynx note.

As the pitch of the larynx note is further raised towards that of the whistle note, the latter tends to adjust itself or "draw" towards the nearest harmonic of the larynx note which lies within it's characteristic range for the vowel in question.

Thus, if a chromatic scale be sung to a given vowel sound, the resonator note will remain constant, but when the note sung approaches within say 2 octaves of the whistle note, this latter may be heard to alternate between or jump from one to another of 3 or 4 neighbouring semitones at each change of pitch of the larynx note.

This last phenomenon has, I find, been already observed by Mr. Perrett.

From these observations it would appear to be possible to make an exclusively acoustic classification of the vowel sounds depending on the range of their whistle and resonator notes respectively.

R. A. S. PAGET.
East India House, 74 Strand, London, W.C.2,
March 3, 1922.

Protective Colloids—A Pretty Lecture Experiment.

As the result of a large number of experiments carried out in the Chemistry Department of this School by Messrs. Vallance, Dennett, Trobridge, Hammond, and Tidmus in conjunction with the writer, it appears to be a general law that protective colloids or organic emulsoids tend to retard the velocities of such reactions, whether chemical or physical, as involve a change of state in one or more of the components.

Thus it is found that the rates of solution of metals in acids, of corrosion in neutral media, of solution and precipitation of salts, of replacement of one metal by another, as, for example, in the familiar lead-tree experiments, etc., are all retarded by protective colloids. In many cases the rate of retardation conforms to the requirements of the adsorption law. Details of these experiments will be published in due course elsewhere.

A very pretty lecture experiment illustrating this retardation is afforded by the precipitation of mercuric iodide on addition of the chloride to potassium iodide. If this is effected in fairly dilute aqueous solution, the unstable yellow form is first precipitated and rapidly turns from orange to red as it becomes converted to the more stable variety.

If, however, the reaction is carried out in the presence of gelatin, say one per cent., the liquid first turns momentarily yellow, due to the formation of colloidal mercuric iodide, then becomes turbid, and a beautiful canary colour develops, which remains practically unchanged for half an hour or more, according to circumstances. Only very slowly does it change to the red polymorph. The protective colloid retards the growth of the yellow particles. Sunlight accelerates the change markedly. With the aid of the ultramicroscope ($\frac{1}{12}$th inch oil immersion) these changes may be seen beautifully. Drops of gelatin and dilute potassium iodide are mixed under the coverglass and the ultramicroscope focussed as usual. A drop of mercuric chloride solution is brought to the edge of the coverglass and is drawn under by capillary action. The field of the ultramicroscope becomes swept with a stream of luminous particles moving with dazzling velocity—the Brownian movement of the colloidal mercuric iodide. The velocity slows down as the particles increase in size, until the colloid range has been passed, and in a few minutes a fine precipitate is obtained evincing scarcely any movement.

J. NEWTON FRIEND.
The Municipal Technical School, Birmingham,
February 27, 1922.

A Problem in Economics.

MANY economic applications of meteorology depend upon the use of forecasts in deciding whether or not to incur expense by taking precautions against some particular phenomenon which would cause damage. A good example is provided by forecasts of ground temperature in deciding whether to pay men to spread sacking over newly-laid concrete road surfaces which would be injured by frost. In the simplest form of such problems the three possible lines of action are (1) to take precautions only on occasions when the phenomenon is forecasted, (2) to take precautions on all occasions, (3) to take no precautions at all. It is of interest to examine the circumstances under which (1) is the most economical line of action.

Let a be the cost of precautions against an event whose probability is P and which will cause damage b if it occurs in the absence of precautions. Suppose the forecast to take the form of a plain "Yes" or "No," and let p be the probability that an occurrence of the event will be preceded by a forecast of "Yes."

With an unbiassed and experienced forecaster it may be assumed that in the long run "Yes" occurs among the forecasts about as frequently as the event occurs. In a large number n of trials, "Yes" will therefore be forecasted on Pn occasions and the expenditure on precautions will be $a \,.\, Pn$.

The event will occur on Pn occasions of which $p \,.\, Pn$ will have been forecasted. The remaining unforecasted occasions will number $Pn(1-p)$ and will entail an expenditure of $b \,.\, Pn(1-p)$ by damage. The total expenditure will therefore be

$$a \,.\, Pn + b \,.\, Pn(1-p). \qquad \text{(I.)}$$

The cost of the forecasts is assumed to be negligible in comparison with a and b.

If precautions are always taken the expenditure will be

$$a \,.\, n. \qquad \text{(II.)}$$

If precautions are never taken the expenditure will be

$$b \,.\, Pn. \qquad \text{(III.)}$$

We have now to compare the amounts involved by I., II., and III. and see which is the least.

I. may be written $b \,.\, Pn - (b \,.\, Pn \,.\, p - a \,.\, Pn)$.

The condition for I. to be more economical than III. is therefore

$$b \,.\, Pnp - a \,.\, Pn > 0$$

or

$$p > a/b.$$

That is to say, the probability of a correct forecast must be greater than the ratio of precautionary expenditure to possible damage. Unless forecasts are very bad or precautions very expensive this condition will be very easily fulfilled.

The condition for I. to be more economical than II. is

$$b \,.\, Pn(1-p) < a \,.\, n(1-P),$$

which expresses the fact that the loss due to possible damage must be less than the saving through omission of precautions. This may be written

$$1 - p < (1/P - 1) \,.\, a/b. \qquad \text{(IV.)}$$

With given values of P, a, and b, IV. sets a limit to the allowable error in forecasting. For example, suppose the chances of the event are even, that is $P = 0{\cdot}5$, the following results are obtained for the limiting values:

$a/b=$	0·01	0·05	0·10	0·20
$p=$	0·99	0·95	0·90	0·80

If the probability of a correct forecast is not above 0·90 it is therefore disadvantageous to base precautionary action on the forecasts unless it costs more than 1*l.* to save 10*l.* worth of damage.

With lower probability of the event things become much more favourable for (1). Thus suppose $P = 0{\cdot}25$ (chances 3 to 1 against the event) we obtain the following results:

$a/b=$	0·01	0·05	0·10	0·20
$p=$	0·97	0·85	0·70	0·40

If in this case the probability of a correct forecast is 0·90 and $a/b = 0{\cdot}10$, the expenditure involved per 100 trials, 1*l.* being the precautionary expenditure, works out as follows:

Taking no precautions	250*l.*
Taking precautions on all occasions	100*l.*
Taking precautions only when the event is forecasted	50*l.*

In practice, the forecaster, being aware that the object of the forecast is to avoid loss by damage, would be biassed in favour of forecasting the event and would only forecast "No" when the odds were considerably against an occurrence. Such a bias would tend to increase p, which was defined as the probability that an occurrence of the event would be successfully forecasted. Against this we would have to set an increased expenditure through needless precautions, and if the forecaster were too cautious this might outweigh the gain resulting from a decrease in unforecasted occurrences. A moderate degree of bias would, however, obviously result in a gain in most cases.

In practice, therefore, the financial results of utilising weather forecasts are likely to be even better than those calculated above.

There is reason to believe that the commercial possibilities of weather forecasts are not fully appreciated. These calculations will serve to show that considerable gain may result from their utilisation, allowing a reasonable margin of error in the forecasts.

E. G. BILHAM.

Age Incidence of Influenza.

THE explanation given by Miss A. D. Betts (NATURE, February 23, p. 240) has always seemed to me an obvious and adequate one. The reply of "The Writer of the Article," that follows it, is admirably clear, and therefore helpful; but I think it really supports the explanation it ostensibly opposes.

Influenza is clearly a disease the incidence and severity of which depend more on the man than on the germ. Some people (apart from the intensive infection and exhaustion of overcrowding and nursing) seem practically immune to it. But all such immunity is probably partial and relative. The successive milder attacks, sometimes not called influenza, that follow a well-marked attack show that the patient is not immune; and any relative immunity is probably largely due to these later successive attacks being treated in time.

In the same way the degree of immunity induced by preventive inoculation is, like other immunity, partial and relative. The inoculated may hope, at least for a time, for substantially increased resistance to infection (but not absolute immunity no matter how intense the infection), and for slighter and briefer attacks if they catch it.

Further, all such relative immunity, if originally present, tends to be destroyed and the severity of the disease and its associated complications increased by exhaustion, whether due to virtuous and patriotic overwork or to vicious dissipation. I do not therefore oppose point (4) of "The Writer of the Article," which is not, however, in dispute here.

But as regards his other three points—

(1) Under end-of-war conditions our young people with unselfish patriotism worked to exhaustion, and largely under conditions involving intensive infection; and as a secondary factor had inadequate food in health and when ill. Again, working as they did largely away from home, the dangerous work of nursing them fell largely on those of their own age, and not, as in normal times, on their parents and elders.

The latter, on the other hand, were not only spared the exhaustion and intensive infection of nursing them, but the "rationing," so trying for the young, was good for us older people, to whom habitual over-eating and drinking is apt to be one of the chief causes of exhaustion and consequent liability to disease, at an age when we should be most immune.

Doubtless the aged were hard hit by the sorrows of the war, which in the end shortened the lives of many; but I take it that, except in the countries actually invaded and ravaged by the enemy, war conditions did not make them more liable to influenza.

(2) Observations on influenza in boarding schools show that those boys who do not readily catch it, and, under normal home conditions, would escape probably entirely, if exposed long enough to the intensive infection of crowded rooms at school, succumb in the

end. This explains the attacks on older people in the later phases of the waves of the war-end epidemic. Their immunity was relative, not absolute.

(3) All European countries, neutral as well as belligerent, were greatly upset and tried by the war; and N. America (Canada and U.S.A.) was belligerent.

GERARD W. BUTLER.

Candahar, Yorke Road, Reigate, Surrey.

Calcium Carbide and the Board of Trade.

THE decision of the Board of Trade Referee that calcium carbide is not a synthetic organic chemical is characterised by "H. E. A." (NATURE, February 23, p. 230) as an offence against both chemical tradition and our chemical conscience. "H. E. A." no doubt may claim to be the keeper of the chemical tradition and conscience of organic chemists, but I should like to dissociate myself personally from his custodianship. How any one can regard calcium carbide, a substance that gives calcium oxide as its sole solid product when moistened with water, as an organic chemical, or an electric furnace operation as the fundamental synthesis of organic chemistry, I cannot understand. What do they know of organic chemical synthesis who only the syntheses of organic chemists know?

FREDERICK SODDY.

PROF. SODDY is a trifle impetuous: my reference to Hazlitt was not out of place, it seems. If I follow my critic, as only a small heap of solid phosphate of lime will be left of me when I am burnt, I am not organic. Granted that calcium acetylide (carbide) gives lime when wetted, it is a little surprising that the putative father of *Emanation* and the first to make clear the significance of helium should attach no importance to the escaping gas. If a man have a wooden leg, he is none the less counted a man, I believe. Now, when zinc ethide is started swimming in water, it leaves behind it its leg, as it were, in the form of zinc oxide, just as carbide does, though in the form of lime; yet the ethide ranks as one of the most honourable of synthetic organic chemicals: why discard the carbide?

One purpose of my article was to direct attention to our lack of logic when using words. Prof. Soddy's comments are but proof that the need to put considered meaning into our words *is* with us. I was led to respect Trench before reading science: in consequence, I have all my life had my attention drawn to words. The term organic has never had any "organic" or vital significance, in chemistry, in Prof. Soddy's lifetime. Thinking chemists have long and logically attached an entirely conventional meaning to it. Before Prof. Soddy was born, I wrote a text-book entitled an "Introduction to the Study of Organic Chemistry," which had as subsidiary title "The Chemistry of Carbon and its Components." I was but adopting a definition put into my hands by my chemical grandfathers. Both carbon and carbonic acid were considered. I would class not only coal but even limestone among "organic compounds."

In conclusion, let me say that the proceedings under the Act are becoming more of a scandal every week. The latest riddle asked is, "When is a chemical not a chemical?" "When it is used as a foodstuff," being the suggested answer. The position of disputants is that defined centuries ago in "Hudibras":

> They're catched in knotted law, like nets;
> In which when once they are imbrangled,
> The more they stir, the more they're tangled,
> And while their purses can dispute,
> There's no end of th' immortal suit.

From beginning to end, every proceeding connected with the Act has been "unscientific." H. E. A.

The Hormone Theory of Heredity.

I SHOULD be much obliged if you would allow me to correct in NATURE, which is, I believe, widely read in the U.S.A. as well as in this country, the erroneous account of my hormone theory of heredity given by Prof. T. H. Morgan in his memoir on Secondary Sexual Characters, Carnegie Institution, No. 285, 1919. At that date Prof. Morgan could only have known the account of my theory in my paper in the *Arch. f. Entwicklungsmechanik*, 1908. His description of my views is contained in the following two quotations from his memoir: (1) "He imagines these hormones to be collected in the germ cells and transmitted to the next generation, where their presence contributes to the further development of the special region (when it develops) that corresponds to the region in its parent in which the hormone was made." (2) "His special appeal to the hormone theory makes use of that theory in a way to which it was never intended to be put, by assuming that an internal secretion formed in one organ can be stored up in another organ, egg or sperm, an assumption not only unsupported by any evidence, but, as I have stated, quite foreign to the hormone theory."

The theory suggested by me in 1908, and put forward in my recent book, "Hormones and Heredity," is that the increased amount of hormones or waste products given out by a structure in which hypertrophy has been caused by external stimulation, may stimulate the determinants or factors corresponding to that structure in the gametes, and so cause some degree of inherited hypertrophy in the next generation. One quotation from my 1908 paper will prove this:

"At the same time the hormone from the incipient antler stimulates the determinants in the gametes. . . . If the stimulation of the determinants is repeated for an indefinite number of generations the congenital tendency to the hypertrophy will become very strong."

The idea of stimulation of a determinant or factor, which may be as Prof. Morgan maintains a part of a chromosome, is very different from the storing up in the gametes of hormones derived from parts of the soma, and for this latter idea I disclaim all responsibility.

J. T. CUNNINGHAM.

East London College, March 6, 1922.

Neon Lamps.

IT does not seem to be generally known that neon lamps, for which many applications can be found in a physical laboratory, are now obtainable very cheaply. They are made to fit an ordinary holder, and contain moderately pure neon (usually somewhat contaminated with mercury) at low pressure. The electrodes are of nickel and are made in various shapes according to the purpose for which the lamp is intended, but they are sufficiently close together for the lamp to run at ordinary supply voltages (down to 100 v.). They are particularly useful for stroboscopic measurements; in this case the lamp is used to illuminate the disc, and may be run from the secondary of an induction coil the primary of which is in series with an electrically maintained tuning-fork.

Another application is to the detection of oscillating P.D.'s in connection with a Fleming cymometer and similar experiments. Possibly, too, they may be of service in spectroscopic work where the dispersion is small or the exposure long, as the lines are not too numerous and their wave-lengths are in many cases very accurately known. Their great advantage over the ordinary neon vacuum tube is of course their cheapness; the last one I purchased cost 3*s*. 9*d*.

W. E. CURTIS.

Wheatstone Laboratory, King's College, W.C.2, March 6.

Photosynthesis.

By PROF. E. C. C. BALY, F.R.S.

PHOTOCHEMICAL reactions, more particularly those in which highly endothermic syntheses take place, have generally been considered as something apart from the ordinary chemical reactions of the laboratory, and, indeed, have at times savoured of the mysterious for the reason that they seemed to be impossible of realisation *in vitro*. Recent work, however, on the energy changes involved in chemical reaction has shown that there is no inherent mystery in photosynthesis, and that all reactions, including those of photochemistry and catalysis, are completely analogous and obey the same laws. Every complete reaction consists of three separate stages, with each of which is associated its characteristic energy change. In general, molecules in the free state exist in a phase which is non-reactive, and in order to carry out any reaction it is first of all necessary to bring them into a reactive phase. This, which is the first stage of the reaction, requires that a definite amount of energy should be supplied to each molecule, the amount necessary being the difference in energy contents of the initial phase and the particular phase necessary for the reaction in question. Each phase of a given molecule differs in energy content by a fixed quantity of energy characteristic of that molecule, which is called the molecular quantum of energy. It follows, therefore, that the amount of energy necessary to activate each molecule in the first stage of the reaction is exactly one or more molecular quanta.

The second stage of the reaction is the atomic rearrangement whereby new molecules are produced, and it is this stage, and this stage alone, which is represented by the equation of the reaction.

The third and final stage is the change in phase of the newly synthesised molecules, whereby they pass into their normal and non-reactive phases. These last two stages are both accompanied by an escape of energy, and in each of them the amount of energy lost per molecule is exactly one or more molecular quanta characteristic of the new molecules. If the sum of the amounts of energy evolved in the second and third stages is greater than that absorbed in the first stage, the reaction is exothermic; whilst an endothermic reaction is one in which the energy necessary for the first stage is greater than the total amount evolved in the second and third stages.

There are three methods by which the energy necessary for the first stage may be supplied. It may be supplied by a material catalyst, or as radiant energy in the form of heat or light. The action of a catalyst does not arise here, and need only be mentioned in order to guard against any misconception. Many reactions take place in solution without the apparent intervention of the first stage, but in such cases the molecules have been activated by the solvent which functions as a catalyst.

In general, it is a matter of little consequence whether a molecule is activated by heat or light—that is, by infra-red or ultra-violet rays—in view of the known integral relationships that exist between the frequencies at which a molecule can absorb energy. It is a matter of cardinal importance, however, in the case of highly endothermic reactions, in which the increment of energy required for the initial phase change is obviously a large number of molecular quanta. When a molecule absorbs energy at its principal frequency in the infra-red, it absorbs it in terms of its molecular quantum; but if it absorbs ultra-violet light the unit of energy absorbed is a quantum which is an integral multiple of the molecular quantum, the multiple depending on the phase in which the molecule exists. One single quantum of energy absorbed at the characteristic frequency in the ultra-violet is always sufficient to activate a single molecule for any reaction, however endothermic this may be.

An endothermic reaction, in the first stage of which each molecule requires a large number of molecular quanta to activate it, will obviously be very much easier to carry out by exposing the molecules to energy of their characteristic frequency in the ultra-violet, when the absorption of one quantum per molecule is sufficient, than by exposing them to infra-red radiation, when the reaction will not proceed until a specific number of quanta have been absorbed by each molecule. When, as is frequently the case, this specific number is ten or more, it is not surprising that the realisation of the reaction by means of heat becomes impossible from the practical point of view. Such a reaction, however, is readily brought about by the absorption of a single quantum by each molecule at its characteristic frequency in the ultra-violet.

This may be understood more clearly from a specific instance, namely, the decomposition of hydrogen chloride into hydrogen and chlorine. The molecular quantum of HCl is about $5{\cdot}7 \times 10^{-13}$ erg, whilst the quantum absorbed at the ultra-violet frequency is about $9{\cdot}7 \times 10^{-12}$ erg, which is seventeen times as large. The activation of an HCl molecule so that it may decompose requires seventeen molecular quanta, and this may readily be brought about by exposing the gas to radiant energy of the wave-length 203 $\mu\mu$, when the absorption of a single quantum per molecule is sufficient. In order to bring about this reaction by heat, it will be necessary for each molecule consecutively to absorb seventeen molecular quanta, without losing any by radiation during the process, before it can decompose. The preparation of hydrogen and chlorine from hydrogen chloride is therefore very difficult to carry out by the aid of heat, but is readily induced by light. Another highly endothermic reaction which may be realised photochemically is the synthesis of formaldehyde from carbon dioxide and water, for it has been shown that under the influence of light of wave-length 200 $\mu\mu$ the reaction takes place according to the equation $CO_2 + H_2O = CH_2O + O_2$. These two examples are sufficient to show that whilst there is no essential difference between any two chemical reactions, those that are highly endothermic can be realised in practice only by photochemical stimulation.

The photosynthesis of formaldehyde from carbonic acid is of great importance, because it undoubtedly forms the first step in the formation of the many complex substances produced in the living plant. Some recent work in Liverpool on this reaction has thrown

light on the mechanism utilised by the living plant in carrying it out, and also on the general problem of the photosynthesis of vegetable products. Although the synthesis of formaldehyde has been carried out photochemically in the laboratory with light of wave-length 200 $\mu\mu$, this is certainly not the case in the plant, for there is present in sunlight no radiation of this wave-length. The plant must in some way carry out the reaction with the absorption of visible light, for it is well known that visible light only is necessary for the photo-assimilation of carbon dioxide. It has been shown experimentally that, if a visibly coloured basic substance be added to the aqueous solution of carbon dioxide, formaldehyde is produced on exposing the mixture to visible light. The coloured substance, being basic, forms a complex with the carbonic acid, and within such a complex the components possess an identical infra-red frequency; that is to say, the molecular quanta of the two are identical. The energy absorbed by the coloured component is radiated at this common infra-red frequency and re-absorbed by the carbonate component. The necessary increment of energy is thus gained by the carbonate component, which is converted into a molecule of formaldehyde and a molecule of oxygen. This type of reaction has been named photocatalysis, the coloured substance acting as photocatalyst. It has been proved that malachite-green, methyl-orange, and *p*-nitrosodimethylaniline act as photocatalysts in this reaction, and in the presence of carbon dioxide give formaldehyde on exposure to visible light.

It has been shown by Willstätter that chlorophyll as it occurs in the plant combines with carbonic acid, and hence there is little doubt that it functions as a photocatalyst. The green-coloured complex absorbs visible light, and the energy so absorbed is transferred to the carbonic acid through the identity of infra-red frequency, with the result that formaldehyde and oxygen are produced. Although this gives a satisfactory explanation of the mechanism by means of which the living plant is able to produce formaldehyde with the aid of visible light alone, the story is far from complete, for there are yet to be considered the formation of carbohydrates from the formaldehyde, and the details of the process whereby the oxygen set free in the photosynthesis is transpired by the plant as gaseous oxygen.

It was shown by Moore and Webster that aqueous solutions of formaldehyde on exposure to ultra-violet light are polymerised to reducing sugars, but no evidence was given of the nature of these sugars or of the wave-length of the light required. It has been shown more recently in Liverpool that the necessary wave-length of the light is 290$\mu\mu$, which at once establishes the fact that the polymerisation is photochemically distinct from the synthesis of formaldehyde. It has also been shown indirectly that the polymerisation of formaldehyde can be photocatalysed; but this is of scientific interest only, since there is no need to postulate such a mechanism in the plant. On exposure to ultra-violet light the formaldehyde molecules are activated, and it is these activated molecules which undergo polymerisation to sugars, since it is well known that ordinary formaldehyde does not polymerise in this way. When the formaldehyde molecules are first produced by photosynthesis they are in the activated form, and may therefore lose energy in one of two ways, either by change of phase to produce ordinary formaldehyde or by polymerisation to give sugar molecules. But it has been proved that the photochemically activated molecules at once polymerise to sugar, and therefore the photochemically synthesised molecules do the same. There is thus no need to consider the activation of the formaldehyde in the plant, for it is already activated when produced. The absence, therefore, of free formaldehyde in the growing leaf is explained by the fact that the photosynthetic process from carbonic acid to sugar takes place without a break. (Baly, Heilbron, and Barker, *Trans. Chem. Soc.*, vol. 119, p. 1025, 1921.)

The mechanism of the process whereby the oxygen, which is produced with the formaldehyde in the photosynthesis, is transpired as gaseous oxygen is one of great importance in view of the energy changes involved. Willstätter has shown that chlorophyll is in reality a mixture of two substances, chlorophyll A and chlorophyll B, and that a molecule of chlorophyll B contains one atom of oxygen more and two atoms of hydrogen less than a molecule of chlorophyll A. Two atoms of oxygen, therefore, are required to convert a molecule of chlorophyll A into a molecule of chlorophyll B, and since this is the exact relation required in the photosynthetic operation it is impossible to believe that it is not utilised. It is in the highest degree probable that a molecule of chlorophyll A combines with a molecule of carbonic acid, and that this complex on exposure to light gives a molecule of activated formaldehyde and a molecule of chlorophyll B. Willstätter hesitates to accept this view, because he found that the ratio of chlorophyll B to A is not altered during photosynthesis; but since he also proved that the velocity of transpiration of the oxygen is equal to that of the absorption of carbon dioxide, this cannot be accepted as evidence. It means only that there is present in the leaf some mechanism whereby the chlorophyll B is deoxidised and reconverted into chlorophyll A. Willstätter has further proved that an aqueous solution of chlorophyll, saturated with carbon dioxide, decomposes on exposure to light, no measurable photo-assimilation of carbon dioxide taking place. This affords an additional proof that there is present in the living plant a mechanism for maintaining the chlorophyll equilibrium.

In the living photosynthetic cell there exist, along with the chlorophylls, two more pigments, carotin, $C_{40}H_{56}$, and xanthophyll, $C_{40}H_{56}O_2$, the relation between the two as regards oxygen being the same as that between chlorophyll A and B. It may therefore be suggested that carotin has the power of reducing chlorophyll B to chlorophyll A, itself being oxidised to xanthophyll. This is supported by Willstätter's observation that the ratio of xanthophyll to carotin is increased during the photosynthetic operation. This increase, though perfectly definite, is not large enough to decrease materially the amount of oxygen transpired.

The complete reaction, $H_2O + CO_2 = CH_2O + O_2$, is highly endothermic, and is accompanied by the absorption of about 150,000 calories per gram-molecule of formaldehyde produced; and it is interesting to note that one quantum of energy absorbed in the

visible region by chlorophyll is not sufficient to induce the complete reaction, since 150,000 calories per gram-molecule is almost exactly one quantum per molecule at $\lambda = 200\mu\mu$. Certain quantitative experiments have shown that a possible explanation of this is to be found in the fact that the carbonic acid is partly activated by combination with the chlorophyll. Alternatively, it is possible that, whilst one quantum of energy at $\lambda = 200\mu\mu$ is required for the complete reaction with the escape of free oxygen, one quantum of visible light as absorbed by the chlorophyll is sufficient to induce the reaction

$$\text{Chlorophyll A} + H_2CO_3 = \text{chlorophyll B} + CH_2O.$$

It is scarcely necessary to point out that either of these alternatives amplifies the principle of photocatalysis as previously defined. In either case the completion of the reaction, whereby the oxygen is abstracted from the chlorophyll B and transpired into the atmosphere, must require a further supply of energy. This second amount of energy is doubtless absorbed by the carotin and xanthophyll, the absorption bands of which lie in the visible region and between those of chlorophyll, so that each can absorb visible light simultaneously and independently. This suggested explanation is now being investigated.

Reference may be made to some other work now in progress at Liverpool which has already given most promising and suggestive results. By the action of ultra-violet light on aqueous solutions of formaldehyde, several hundred grams of concentrated sugar syrup have been prepared. Analysis of this syrup has shown that the sole products of the polymerisation are hexoses, no trace of a triose or pentose having been found. This result is very striking in view of the greater possibility on the kinetic theory of the formation of sugars containing fewer than six carbon atoms. There can therefore be no possible doubt that the sole products of the polymerisation of the activated formaldehyde as photosynthetically produced in the living plant are also hexoses. Not only does this afford a ready explanation of the storage of starch in the chloroplast during the period of photosynthetic activity and its subsequent hydrolysis to hexoses, which are utilised by the plant in later syntheses, but it also establishes the fact that pentoses must be formed from hexoses, possibly through furane compounds; further, it opens the door to most promising theories of the synthesis of other plant products, every stage of which is attractive in its simplicity.

Then, again, there is the question of the production of the various nitrogen compounds in the plant, which is one of considerable interest, since it would seem that the principal source from which the plant derives its nitrogen is potassium nitrate. It is well known that metallic nitrates are readily converted to nitrites by material catalysts as well as by ultra-violet light. Baudisch has shown that an aqueous solution of potassium nitrite and methyl alcohol, on exposure to ultra-violet light, gives formhydroxamic acid, the alcohol first being converted to formaldehyde. This has been confirmed at Liverpool by investigation of the action of ultra-violet light on aqueous solutions of potassium nitrate or nitrite containing formaldehyde, and it has been proved that an activated molecule of formaldehyde combines with a molecule of potassium nitrite according to the equation $CH_2O + KNO_2 = CH(OH):NOK + O$, since the reaction takes place only in the light. It has also been found that if the activated formaldehyde is in excess formhydroxamic acid and hexoses are simultaneously and independently produced. This condition is doubtless that which obtains in the plant, and it may be concluded that the two syntheses take place in the leaf without mutual influence. It is worthy of note that the photosynthesis of formaldehyde and the synthesis of formhydroxamic acid are both accompanied by the setting free of oxygen.

Experiments are also in progress on the reaction between activated formaldehyde and ammonia, and although these are not yet complete, they have already established the great reactivity of activated formaldehyde towards ammonia. Whatever, therefore, may be the starting point on the nitrogen side, potassium nitrate or ammonia, there is no question that, in the presence of activated formaldehyde such as is produced photosynthetically in the plant, compounds are formed in which carbon and nitrogen are united, thus securing the first step towards protein, pyrrole, and alkaloid synthesis.

Finally, one very important deduction may be made. The sole photosynthetic process in the living plant would seem to be the production of activated formaldehyde from carbon dioxide and water. These activated molecules either polymerise to hexoses or react with potassium nitrite or ammonia. Any further reactions are not photochemical except in so far that the first synthesised nitrogen compounds combine with more molecules of activated formaldehyde to give complex nitrogen derivatives.

The Migration of British Swallows.

By Dr. A. LANDSBOROUGH THOMSON, O.B.E.

"Sister, my sister, O fleet sweet swallow,
Thy way is long to the sun and the south."
SWINBURNE.

FROM time immemorial the Swallow (*Hirundo rustica*, Linn.) has been a proverbial type of summer visitor to our northern lands, but age-long familiarity with the fact of its seasonal appearance and disappearance has not served to bring us complete knowledge or understanding: there are many secrets, both matters of fact and questions of interpretation, to which we have as yet no clue. Nevertheless we are in a better position to appreciate the problem than were Gilbert White and his contemporaries, who were obsessed with the idea that hibernation, particularly in regard to this species, might play an important part as an alternative to migration. White was particularly influenced by the frequent phenomenon of the few "early swallows" which appear some time before the main contingents arrive, and are no more seen if wintry weather should recur in the meantime. The theory of hibernation dies hard even to-day, and every now and then some imperfect piece of evidence in its

favour is recorded—cases, for instance, of birds lingering in autumn being overtaken by hard weather and being found in a comatose condition, really moribund rather than dormant. The further idea that the place of hibernation was in the mud at the bottom of reedy ponds was regarded with sufficient seriousness in the time of John Hunter, the famous anatomist, for him to examine it scientifically; with a truly modern appreciation of experimental methods, he confined swallows in a conservatory one autumn, providing them with water, reeds, and mud, and the result naturally confirmed his scepticism.

Nowadays we know enough of migration to have no need to explore alternative theories, but it still remains true that we see migration actually in progress comparatively seldom, although perhaps we do so more often in the case of swallows than in that of most small birds. The writer recalls one fortunate occasion, for example, when he spent the morning of a bright autumn day sitting at the extreme northern apex of the isle of Heligoland watching the swallows coming in over the sea in the teeth of a southerly gale. For hours there was a steady succession of small bands of from half-a-dozen to a score of swallows, all flying low over the sea and coming into sight as they rose to the level of the cliff-tops. All the birds kept to the same course, the stream following the line of the western cliffs and quitting the island again at its south-western corner. Only an occasional bird circled round for a few minutes, and none seemed inclined to break its journey so early in the day in spite of the adverse conditions. But a glimpse of this kind is only seeing in momentary cross-section, so to speak, one tiny rivulet of the great emigratory stream of swallows from Northern Europe.

Much has been learnt, however, by the careful piecing together of observations collected from many different places, notably from the lighthouses and lightships round the British coasts. From these data Dr. Eagle Clarke was able to give us some years ago, in the report of the special committee appointed by the British Association, an elaborate summary of the movements which usually take place in the British area, and more recently this has been supplemented by the labours of a committee of the British Ornithologists' Club. A few early birds may appear in March, but the average times for the arrival of the vanguard of our summer visitant swallows are:—for south-western England the beginning of the first week in April, for Ireland the end of that week, for south-eastern England early in the second week, for south-western Scotland the end of the same, for south-eastern Scotland the middle of the third week, for northern Scotland the fourth week, and for the Orkney Isles the second week of the following month; the main influx usually begins some ten or twelve days later in each case. The earlier dates for the western regions, latitude being equal, are noteworthy, and it appears that the immigratory waves arrive along the whole length of the south coast of England, but first and chiefly on its western half. Before this immigration of our native birds has been completed—at the very end of April—there begin the passage movements of swallows traversing the eastern seaboard of Great Britain *en route* for northern Europe, and these movements may be prolonged until almost the middle of June.

Decided southerly movements within the British area begin towards the end of August, and early in September actual cross-channel emigration sets in and continues for nearly two months, after which only stragglers are as a rule recorded. From the middle of September onwards there is also the return passage of swallows from Northern Europe, and the two sets of movements are not easily distinguishable. There is also a passage movement from Central Europe, first observed by Dr. Eagle Clarke from the Kentish Knock Lightship, the line of flight being roughly from east to west; the existence of a corresponding spring passage on this line has not been definitely established. A very few instances are on record of swallows surviving in this country throughout exceptionally mild winters.

Within the last few years the method of marking birds with numbered aluminium rings has been widely employed in this country, under the auspices both of the magazine *British Birds*, edited by Mr. H. F. Witherby, and of the University of Aberdeen. The proportion of marked swallows recovered is unfortunately very small, for out of 1198 marked during the Aberdeen scheme only five, or 0.4 per cent., were recovered. The *British Birds* scheme, which is still actively in progress, has nevertheless yielded a very interesting series of records for the species, representing a vast amount of energy in marking; 7597 had been marked up to the end of 1920, and 60 (or 0.7 per cent.) have been recovered. A brief summary of the results of this work, taking the published data of the two schemes together, may accordingly be given with advantage.

There are, to begin with, various records of swallows marked as nestlings and recovered within a few miles a little later in the same season, but these are without special significance. The European stages of migration are indicated by records of birds marked as nestlings and reported in their first year, as follows: one marked in Lancashire from the Isle of Wight late in October; one marked in Lancashire from Indre-et-Loire, in the centre of France, in September; one marked in Staffordshire from Charente-Inférieur, south-western France, in October; and one marked in Staffordshire from Brittany in December, but without information as to how long it may have been lying dead before it was discovered. Further, a swallow marked as a nestling in Staffordshire was recovered at Bilbao, northern Spain, in March of the following year.

Four swallows marked as nestlings, all under the *British Birds* scheme, have been recovered in South Africa during their first winter: a Lancashire bird in Cape Province in February, an Ayrshire bird in the Orange Free State in March, a Yorkshire bird in East Griqualand in February, and a Stirlingshire bird in the Transvaal in January. A swallow marked in Staffordshire as an adult, also, was recovered in Natal in December of the second winter thereafter. Mr. Witherby has directed attention to the suggestive fact that all these five records of his are from the eastern portion of South Africa. A swallow marked in Schleswig-Holstein was obtained on migration at Bregenz, on the Lake of Constance; another, marked as a nestling in Overijsel, Holland, was recovered on October 1 of the same year at Tangier, Morocco.

Of great interest, also, are the records which indicate

the return of swallows to their native districts in subsequent summers. Seventeen marked as nestlings have been so recorded, sixteen in the following summer and one in summer two years after marking, the localities ranging from Hampshire to Kincardineshire. Six marked as adults have been similarly recorded, three after one year and three after two years, the localities ranging from Staffordshire to Peeblesshire.

In some of the foregoing cases the return to the same place was very exact—even to the self-same porch or outhouse. In others the place of recovery was a few miles from the place of marking; a swallow marked as a nestling at Beaulieu (Hampshire), for instance, was recovered in the following May at Ringwood, in the same county but 18 miles distant. There are other cases, still to be mentioned, in which swallows marked as nestlings returned in the following summer to parts of the country rather more widely separated from their respective birthplaces, the distances being from Hampshire to Sussex (30 miles), from Hampshire to Middlesex (70 miles), from Stirlingshire to Yorkshire (170 miles), and from County Kildare to County Armagh (75 miles).

Migration of swallows from Great Britain to South Africa is thus clearly established, and it is also now certain that the birds commonly return to the same summer quarters, often with great exactness, in subsequent years. Much still remains to be learnt, and some of this the marking method may give us in time. What route is followed between Great Britain and South Africa, for example, and are the identical winter quarters repeatedly sought out in the same way as breeding-places? Further, how do the migrations of British swallows compare with those of swallows native to other countries: can we, for instance, confirm Dr. Hartert's suggestion that "the most northerly dwellers migrate furthest south, while the breeding birds of the Atlas Mountains probably go only to the oases of the Sahara for the winter"? These questions strike at the very roots of the nature of the migratory instinct, one of the great wonders of the animate world.

Obituary.

Prof. Benjamin Moore, F.R.S.

By the death of Prof. Benjamin Moore, at fifty-five years of age, science has suffered the loss of an original and daring thinker. Moore was born, and studied, in Belfast, and the first degree he took was Bachelor of Engineering. At one time he thought of following that profession. He received a travelling research scholarship, and studied physical chemistry under Ostwald in Germany, and then came to London and studied physiology under Sharpey Schafer. From thence he went to fill a chair at Yale Medical College, but returned a few years later to be lecturer in physiology at Charing Cross Medical School, and at the same time to qualify himself as a medical man—a double task requiring much nerve, energy and courage. Moore was then elected to the newly-founded Johnston chair of biochemistry at Liverpool—the first chair in that subject to be founded in this country. He took a most active share in the development of the Medical School at Liverpool University, and jointly with Mr. Whitley founded the *Biochemical Journal*. He was elected a Fellow of the Royal Society in 1912. In 1914 he accepted an invitation to join the Department of Applied Physiology under the Medical Research Council, and after rendering valuable services to industrial medicine during the War, was elected, in 1918, to the newly-founded Whitley chair of biochemistry at Oxford. There he quickly inspired several of his honour school students to carry out pieces of research work, and all too soon he has passed from thence, the victim of influenza. He took the greatest interest in Public Health, and a State Medical Service, as shown by his book "The Dawn of the Health Age."

Moore was a man of impetuous imagination, conceiving brilliant ideas, and stimulating others by these and his enthusiasm; he was impatient under the necessarily slow accumulation of results required for confirming his ideas—an impatience which sometimes led him to be too hasty in publication, and to subject himself to criticism whereby his spirit was vexed and his energy wasted in controversy. He was perhaps sometimes wild, sometimes wrong, but often the pioneer in visions of great value. To him we owe the first attempts in this country to apply the results of physical chemistry to the intricate problems of biology. The article by Moore published in "Recent Advances in Physiology," edited by L. Hill, and last year elaborated and republished in book form, did much to found the British school of physico-chemical physiology.

Moore was fascinated by the problem of the origin of life, and formed conceptions of the first steps in the evolution of life by the synthesis of inorganic compounds. He was able to show the formation of formaldehyde from CO_2 and H_2O under the influence of sunlight on a commonly occurring substance like iron oxide. This was the beginning of a series of papers on photosynthesis, on which a value higher than at present will probably be set in future time. He recently demonstrated the production in the air of oxides of nitrogen by the action of sunlight, and conceived the assimilation of these when dissolved in rain and dew by the green leaf. He was a pioneer in the work which is now given so much attention among physiologists, namely, on the normal reaction of body fluids and the maintenance of this normality, acidosis, etc.

Tackling the problem of trinitrotoluene poisoning, which was working havoc in munition factories during the War, Moore found that the chief danger was due to the absorption of this material through the skin—a view which met with considerable opposition, and led to controversial strain upon his sensitive nature. This discovery, when fully accepted, enabled thousands of workers to be preserved from poisoning during the War, and saved the country paying out hundreds of thousands of pounds in the settlement of employers' liabilities.

The sudden death, from appendicitis, of Moore's wife, who was devoted to his care, was an irreparable loss to him, and made a vast difference to the happiness and health of his last years. He leaves one son—a chemist in training—and two daughters. L. H.

Dr. A. D. Waller.

We record with much regret the death on March 11, at fifty-five years of age, of Dr. A. D. Waller, director of the physiological laboratory and professor of physiology in the University of London.

M. Camille Jordan.

By the recently announced death of Camille Jordan the mathematical world has sustained the loss of one of its greater modern analysts. Born in 1838 Jordan succeeded Chasles (1881) in the geometrical section of the Paris Academy of Sciences. Later he was given the chair of mathematical analysis at the École Polytechnique, from which he retired a few years ago.

In the earlier part of his career Jordan's mathematical work was mainly geometrical. An important memoir is concerned with polyhedra and the attendant geometry of position. In another paper he obtained the condition that two flexible and extensible surfaces should be applicable to one another without tearing or doubling over. His work on symmetry and displacement-groups anticipated later research on transformation-groups, and has been used in theoretical crystallography.

Jordan left his deepest impression, however, by his work on substitutions and algebraic equations. In his "Traité des Substitutions" he followed up Galois' ideas, obtaining fundamental results on primitive, transitive, and composite groups, and on the composition-factors of a group. These investigations enabled him to settle a question proposed by Abel, *viz.* to decide whether a given algebraic equation is soluble by radicals or not. Other work of Jordan's is concerned with algebraic forms and linear groups of finite order, with their applications to algebraic integrals of linear differential equations.

Some of Jordan's more recent work was on the theory of functions of a real variable. His name will be remembered as the discoverer of *Jordan curves*, the most general curves which cut a plane into two distinct portions.

W. E. H. B.

Current Topics and Events.

The call for economy in the Civil Service has produced a number of letters in the correspondence columns of *State Technology*, the journal of the Institution of Professional Civil Servants, from members who do not belong to the administrative section of the service or to the clerical section from which the administrative is recruited. The object of these letters is to show that great saving might be effected by making better use of the professional, scientific, and technical officers of the service. At present it often happens that progressive scientific development is hampered by the existence of a control without knowledge of the scientific work on which the professional members are engaged. Such a control tends towards a stereotyped system in which each member of the service becomes a mere machine without inspiration or initiative, and to the promotion of clerks into secretaries, deputy secretaries, assistant secretaries, etc., at salaries out of all proportion to the value of their services to the State. From letters in the February number of the journal it appears probable that some of these facts are to be discussed in the daily press in the near future.

The Field Museum of Natural History, Chicago, announces several collecting expeditions. Mineralogists will visit the gem-producing and the gold- and copper-producing districts of Brazil, the silver- and copper-producing districts of Peru and Bolivia, and the nitrate and vanadium deposits of Chile. Fossil vertebrates will be sought in Patagonia, northern Argentine, and Brazil. Zoologists and botanists will be associated in the Sierras of Central Peru and round the sources of the Amazon. Archaeologists will visit the Isthmus of Panama, the State of Colombia, and the Colorado Desert. Dr. Fay-Cooper Cole is to study the races of the Malay Peninsula and to explore the interior of Borneo. Dr. Berthold Laufer proposes to study the aboriginals of Hai-nan, and to make archaeological collections in Fu-kien and Manchuria.

A violent gale traversed the southern portion of England during the night of March 7 and the forenoon of March 8. The storm arrived from the Atlantic and was first experienced on our south-west coasts, whence it travelled across the south and east of England to the North Sea. In the English Channel and at the southern English stations the south-westerly and westerly winds attained hurricane force. At Scilly the wind blew with the velocity of 108 miles an hour at 4 a.m., a speed which has only once previously been exceeded in the United Kingdom, the wind in a gale on January 27, 1920, registering 110 miles an hour in Co. Clare, Ireland. The storm was accompanied in most parts by heavy rains, and the violence of the wind occasioned a large amount of damage.

Under the title "Research Laboratories in Industrial Establishments of the United States, including Consulting Research Laboratories," a Bulletin of the U.S. National Research Council (1921, vol. 3, Part I., pp. 135) has recently been issued. The report gives an alphabetical list of 526 industrial establishments in the U.S.A. having research laboratories, the name of the chief worker, the number of the staff, the nature of the work, and the special equipment, together with a subject classification and index, and a list of the directors of research with addresses. It is a most interesting compilation, furnishing useful details not only of the enormous staffs of such companies as E.I. du Pont de Nemours, Eastman Kodak, Goodyear Tyre, General Electric, and Western Electric, but even of the small laboratories with only one or two workers. It is very plain, however, that the term "Research" has been generously applied, for the vast majority of the laboratories would be modestly referred to in this country as "works laboratories." The equipment catalogued is also quite conventional in most cases, but it is amusing to read that the Edison laboratory has a "large scrap heap from which to rob to build

other apparatus," and some scientific workers may envy the lot of the two members of the staff of a sugar company who have a "candy kitchen" at their disposal. It is flattering to the chemist to find how largely he preponderates in the various staffs, but many an industry would be better served by the co-operation of other scientific workers, especially physicists.

Among the pioneers of the locomotive a high place is deservedly given to Timothy Hackworth, who was born December 22, 1786, and died July 7, 1850. No complete biography of Hackworth has yet been written, and his merits apparently escaped the notice of the compilers of the "Dictionary of National Biography." This rendered all the more welcome the interesting review of his work which Mr. Robert Young, a grandson of Hackworth, gave to the Newcomen Society at the meeting held on March 1. Hackworth's youth was spent at Wylam Colliery, where Hedley built his "Puffing Billy." By 1824 he was sufficiently well-known to take charge of Stephenson's works at Newcastle, and the following year he became engineer and manager of the famous Stockton and Darlington Railway. For this line he built the "Royal George," which definitely asserted the superiority of steam over horse traction, and a year or two later the "Sans Pareil," a powerful competitor with Robert Stephenson's "Rocket" in the Rainhill trial of October 1829. If for nothing else Hackworth deserves recognition for his discovery of the proper manner of discharging the exhaust steam up the funnel so as to create a powerful draught through the furnace. He was, however, far more than a successful inventor. For fifteen years he managed the Stockton and Darlington Railway, and his workshops at Shildon became a training ground for locomotive engineers. He was also a great captain of industry and set an example in his treatment of his workmen. All these matters were touched upon in Mr. Young's paper, and information was given about many of the engines Hackworth constructed, among them being the first locomotive to be sent to Russia, and also the first to be run in British North America.

Prof. B. Brauner, professor of chemistry and director of the chemical laboratory, Bohemian University, Prague, has sent us an article, which we hope to publish in a week or two, on work done by Bohemian men of science during the war and after. He has been a reader of Nature for forty-two years, and has on a number of occasions made original communications to its columns. We particularly appreciate, therefore, the following reference to this journal in an article contributed by him to the leading Bohemian periodical, *Národní Listy*, of December 21 last:—"My favourite reading is the London journal Nature, circulating over the whole world and bringing articles about all acquisitions of the human spirit, from bacteria to the Egyptian 'Book of the Dead,' from the structure of atoms to the structure of the universe. The magnificent work of my teacher Bunsen and of Kirchhoff on spectrum analysis, together with the principle of our Doppler (who lived in Prague), which led us to understand of what and how the stars are formed and how they move; the work of Kekule ze Stradovic, a descendant of the Protestant exiles of Bohemia three hundred years ago, on the structure of matter; photography, Darwinism, theory of evolution, Mendeléeff's periodic system, Röntgen's discovery, Becquerel's discovery of radioactivity and the great chemical and electrical discoveries connected with it, which led to our knowledge of the innermost constitution of the atoms—of all these discoveries and their evolution and progress Nature brings each week the most recent information. Everything described is connected together as a whole and yields a magnificent picture of Nature on the earth and in the universe. It is our religion—reverence to the One Who all this, and also ourselves, created of the original nebula, *i.e.* almost of nothing, and at the same time admiration of the human spirit which investigated and conceived it."

On Wednesday, March 1, there was opened at the British Museum a special exhibition of Greek and Latin papyri presented at various dates by the Egypt Exploration Society. This body (formerly the Egypt Exploration Fund) is celebrating the twenty-fifth anniversary of the foundation of its Græco-Roman Branch, the excavations of which at Behnesa (Oxyrhynchus) and elsewhere have made so many additions to our stock of Greek literature and to our knowledge of the political, economic, and social history of Græco-Roman Egypt; and it is in honour of the anniversary that the Museum is arranging its exhibition. A guide-book to the exhibition, with introduction, detailed descriptions of the papyri shown, a preface by Sir Frederic Kenyon, and one photographic facsimile, is being published by the Society, and will be on sale at the Museum, price 1s. The exhibition, which will be found in the MSS. Saloon, Case A, includes many interesting papyri of various kinds, selected to illustrate the wide range of papyrological discovery. There are examples of famous additions to Greek literature, like the Pæans of Pindar, the poems of Cercidas, and the Oxyrhynchus historian; theology is represented by the Sayings of Jesus; and the economic and social life of Egypt finds illustration in many non-literary documents, several of them rich in human interest.

In the middle of January the first issue of a new technical publication appeared entitled *Oil Engineering and Finance*, a journal intended for the producer and user of petroleum and also for the investor. A feature of the enterprise is the division of the paper into sections, each dealing with a particular phase of the industry, such as oilfield development, oil refining, fuel and lubricating oils, oil fuel, heavy oil engines, and the home oil industry, each section being under the editorship of a specialist in the particular branch under discussion. The first issue is almost entirely devoted to a comprehensive review of the petroleum industry in 1921 under the above headings, and, as such, is a most useful number. It is well put together, carefully printed, and the illustrations are good, and we can only express the hope

that future issues will conform to the standard aimed at by the promoters, and certainly achieved at the outset. The entire absence of an endeavour to influence the purchase of particular oil shares—an unfortunate feature of so many petroleum publications—is a sound policy which, if adhered to rigidly, will go far to establish this journal on a firm basis.

IN the Annual Report for 1921 of the Council of the Institution of Mechanical Engineers it is announced that the Thomas Hawksley Gold Medal for 1922 for the best paper published in the society's proceedings of the previous year has been awarded to Prof. E. G. Coker for a paper written in conjunction with Dr. K. C. Chakko and Mr. M. S. Ahmed on "Contact Pressures and Stresses." Other awards are grants of 20*l*. each to Mr. R. L. Smith and Mr. G. E. Sandland from the Sir Robert Hadfield prize fund for their communication entitled "An Accurate Method of determining the Hardness of Metals, with particular reference to those of a High Degree of Hardness." Prizes from this fund will not be offered again, and the unexpended balance of the capital sum will be used for assisting research. It is also announced that a scheme has been established in conjunction with the Board of Education for the award of National Certificates and Diplomas on the results of group part- and full-time courses at approved technical schools and colleges.

THE second annual report of the Industrial Fatigue Board to the Medical Research Council (pp. 65, H.M.S.O., 1922, 1*s*. 6*d*. net) is far more than a mere Report of the Board; only fourteen of its sixty-five pages are devoted thereto. The remainder consists in an instructive and valuable analysis of the published work of the Board, divided into the following five sections:—(i.) scope and method of its investigations; (ii.) hours of labour, spells, rest pauses, etc.; (iii.) other conditions of work, such as temperature, humidity, ventilation, and lighting; (iv.) methods of work, including vocational selection and guidance, and time and motion study; and (v.) miscellaneous points, *e.g.* organisation, human and technical factors in efficiency. The Secretary of the Board, Mr. D. R. Wilson, is to be congratulated most heartily on the report and on his successful organisation of its varied activities. Of these it is noteworthy that a large proportion (one half of the reports issued by the Board and of papers based on work done for it) have been contributed by investigators who have received special training in experimental psychology.

THERE has recently been issued "A List of Seismological Stations of the World" as vol. 11, No. 15, of the *Bulletin of the National Research Council* (U.S.A.). It was compiled under the auspices of the Section of Seismology of the American Geophysical Union, with the co-operation and assistance of the Research Information Service of the National Research Council. This list is incomplete owing to conditions prevailing generally after the world-war, and it is desired to correct and complete the information in the files of the Research Information Service in preparation for a revised edition of the publication. To that end a further revised *questionnaire* is being distributed with the printed list. Extra copies of the *questionnaire* are available, and will be sent to all who have additional information to contribute. It is requested that every one who notes errors or omissions in the list as issued should bring these to the notice of the Section of Seismology of the American Geophysical Union, addressing communications in care of the Research Information Service, National Research Council, 1701, Massachusetts Avenue, N.W., Washington, D.C., U.S.A. It is hoped, further, that complete as well as accurate information may be supplied concerning all stations not now fully described.

BRIEF statements on the position of the various research committees appointed by the Institution of Mechanical Engineers from time to time appear in the Report of the Council for the past year. The Committee on Alloys Research under the chairmanship of Sir John Dewrance has completed its work on aluminium alloys and is continuing that on the alloys of iron. Research work on the stresses in tools and material cut has been carried out by Prof. E. G. Coker, using polarised light and transparent models, for the Cutting Tools Research Committee, also under the chairmanship of Sir John Dewrance, and Col. Compton has experimented on the simplest form of cutting. Work for the Hardness Tests Research Committee, under the chairmanship of Dr. W. C. Unwin, has been carried out by Dr. T. E. Stanton at the National Physical Laboratory on the comparison of ball and cone tests and of scratch and indentation tests for very hard steels. The Steam-Nozzles Research Committee, under the direction of Capt. H. Riall Sankey, has investigated the efficiency of Parsons' nozzles; the expenditure of this committee during the year exceeded 900*l*., and a balance of less than 200*l*. remains. Work for the Wire Ropes Research Committee, of which Mr. C. W. James is chairman, has been carried out by Dr. W. Scoble on repeated bending tests of wire ropes.

THE representative meeting at Glasgow of the British Medical Association will begin on July 21. The statutory annual general meeting commences on July 25, and the presidential address will be delivered by the president-elect, Sir William Macewen, during the same evening. Prof. J. Graham Kerr is to give a popular lecture on the evening of July 28. The following have been elected presidents of sections: Prof. T. K. Monro, medicine; Dr. G. M. Robertson, neurology and psychological medicine; Mr. A. S. Percival, ophthalmology; Prof. R. Muir, pathology; Prof. H. A. Thomson; Mr. R. MacN. Buchanan, microbiology (including bacteriology); Prof. J. A. McWilliam, physiology; Dr. A. K. Chalmers, public health; Prof. A. Macphail, anatomy; Prof. J. Glaister, industrial diseases and forensic medicine; Mr. L. A. Rowden, radiology; and Sir Robert W. Philip, tuberculosis. The honorary local general secretary is Dr. G. A. Allen, 22 Sandyford Place, Glasgow, W.

Our Astronomical Column.

The Partial Solar Eclipse of March 28.—This eclipse is a successor, after twelve lunations, of the large eclipse of last April. On this occasion the central line has moved southwards, crossing Brazil and the Sahara. The whole of the British Isles enjoy a partial eclipse, the magnitude of which diminishes from 0·20 at Greenwich to zero at the Shetlands. At Greenwich the eclipse begins at 1.19 p.m. at the lowest point of the disc, attains its greatest phase at 2.15, and ends at 3.8. The only observations of importance that can be made are the timing of the contacts and the watch for lunar mountains at the edge of the moon.

Photography of the Ultra-violet Solar Spectrum.—MM. Charles Fabry and H. Buisson give an account of their work in this field in the *Astrophys. Journ.* (December). They state that existing material on this region is unsatisfactory; Rowland's map is disturbed by a spectrum of another order; that of Higgs stops at λ3000; and Cornu's map was made by hand from Simony's photographs. Fabry and Buisson's photographs were taken at Marseilles in May and June 1920. They used two quartz spectrographs, the prism edges in them being perpendicular to each other, and state that they thus eliminated diffuse light of longer wave-length, which is one of the chief difficulties in this region. Another difficulty, due to the rapid increase in exposure-time as the wave-length grows shorter, was overcome by using an occulting screen, which was moved by hand at a calculated rate along the spectrum during exposure; the extreme exposures were in the ratio of 1 to 1000. They state that they were able to estimate the varying amount of ozone present in the air by its absorbing effect on these short waves. They give the mean amount of ozone in the air as 0·4 c.c. per cubic metre; as this is much larger than the amount near the ground, they conjecture that it is mainly at a great height (say 50 km.). Two reproductions are given of the spectrum from λ2898 to λ3150; the definition is good and numerous lines are shown, the wave-lengths of which are promised shortly; they include the lines designated *r*ST*t*U. The region λ2965 to λ3030 appears on both photographs, the agreement being good, but with differences in the relative intensities of lines.

The authors note that the intensity of spectrum at the sun's limb is about half that at the centre, this factor remaining nearly constant throughout the region studied. They conclude that the fairly abrupt termination of the spectrum at λ2898 is due to the terrestrial, not the solar, atmosphere.

A Criticism of Majorana's Theory of Gravitation.—The *Astrophys. Journ.* for December contains a criticism of this theory by Prof. H. N. Russell. It will be remembered that the theory, which was based on the apparent alteration in the weight of a mass of lead when surrounded by mercury, asserts that gravitation is subject to absorption by intervening matter. Prof. Russell shows that a sphere composed of homogeneous spherical layers would still attract external bodies according to the inverse square law; as though its mass were concentrated at the centre; thus it would not give rise to any motion of perihelia, as some have supposed. However, the apparent mass of the sphere, as measured by its attraction on external bodies, would be less than its true mass, the deficiency increasing as the central condensation of the matter in the sphere increases. It is then proved that a massive planet would be considerably nearer to the sun than a planet of small mass with identical period. Jupiter, in particular, would be nearer to the sun by 1 per cent. than the accepted distance; but this is inadmissible, since it would produce an error of 7′ in the geocentric place when the planet was in quadrature.

Another test applied is the difference between the heights of the tides when the sun and moon respectively are above and below the horizon. It is shown that the theory would give results totally at variance with observation. Lunar theory supplies a further test, since the attraction of the sun on the moon would produce an acceleration greater by 1·6 per cent. than that experienced by the earth. Prof. Russell concludes that Majorana's theory must be abandoned; he suggests tentatively that the phenomena observed by Majorana might be explained on the assumption that the presence of a large mass itself diminishes the masses of neighbouring bodies: "the space-curvature produced by one mass of matter might be modified by the superposition of that due to another." He admits, however, that this theory also gives rise to difficulties.

The Definition of a Nova.—The Rev. J. G. Hagen directs attention to the advisability of formulating a definition of a nova which takes into account our present knowledge of the nebulous material surrounding new stars, and also class O stars and planetary nebulæ (*Astrophysical Journal*, vol. 54, No. 4, p. 229). Seeliger, so long ago as 1886, put forward the idea that temporary or new stars originated from collisions between stars and cosmic nebulæ, and this theory is now generally adopted. Dr. Hagen's view is that by assuming that the nebulæ are cometary—that is, become luminous at the approach of stars—many facts of observation are explained. Thus the observations account for nearly all the peculiarities of new stars, especially the range of magnitude, shape of the light-curve, character of the spectrum, and the rarity of occurrence; they also show a physical similarity to the O stars and planetary nebulæ.

The collision between the star and the nebula is discussed and the possible results of four types of encounters are given. Then it is shown that a transit without contact might produce a nova with a relatively small range of variation. If the star grazed the nebula and the occurrence was repeated occasionally an irregular variable would be the result. The passage of the star through the nebula might result in a nova of the ordinary type and in a star with a nebulous envelope like an O star. If the star were captured by the nebula a variable of the δ Cepheid type or a planetary nebula would be evolved. The definition of a nova is thus given: "A cometary nebula brought temporarily into close proximity or contact with a bright star."

The Stellar Magnitude of the Ringless Saturn.—Mr. J. van der Bilt investigates this subject in *Bull. Astron. Instit. of Netherlands*, No. 6. Capella, Vega, Procyon, Spica, Pollux, Regulus, and Polaris were used as comparison stars, their magnitudes being revised by the author's observations. The value obtained for Saturn in opposition (Ringless) is 0·84 mag., that given by Müller being 0·877. The chief value of this work lies in the deduced value of the planet's albedo. Similar determinations made when the rings are wide open will give a determination of their albedo, and may give a clue to the constitution of the ring-particles. Mr. van der Bilt has also investigated the effect of phase angle on magnitude, and found the change for 1° of Saturnicentric angle between sun and earth to be 0·050 magnitude, which is in good accord with the mean of other observers.

Research Items.

CLASSIFICATION OF NEMATODES.—Dr. H. H. Cobb sets forth in *Nematology* (8) a classification of nematodes "based on a study of several hundred genera" and depending chiefly on the characters of the mouth and related organs; and in the following part (9) gives systematic descriptions of about one hundred, mostly free-living, new species of nematodes, which form the type-species of nearly as many new genera. Among the morphological points may be noted the following: the large percentage of species with pointed setæ, the complex distal ends of the cephalic setæ in some species indicating their sensory nature, and the presence in a large group of nematodes of six well-developed pharyngeal onchia or spears having an outward stroke and adapted for digging.

FORESTRY IN SWEDEN.—The Forestry Research Institute (Skogsförsöksanstalt) of Sweden, with the view of making its scientific publications better known to the general public, has recently begun the free issue of a series entitled *Skogliga Rön*, which gives the main points of the larger memoirs, emphasising those of direct practical importance. No. 1, by Olof Tamm, deals with the constitution of the soil in the primæval forest of Northern Sweden. The Institute, in addition to its periodical *Skogen*, publishes leaflets, of which we have received *Flygblad* No. 23, by E. Wibeck, on some new forest-cultivating machines, such as root ploughs and sowing apparatus, and *Flygblad* No. 24, by O. Tamm, discussing the dependence of forest growth on the mineral constitution of the soil. Those interested can obtain these publications on application to the Institute at Experimentalfältet, Stockholm.

THE DOVE MARINE LABORATORY, CULLERCOATS.—The Report for the year ending June 30, 1921, of the Dove Marine Laboratory, Cullercoats, is devoted chiefly to an account of trawling investigations carried out in the inshore waters of the coast of Northumberland, which were suspended in 1913 and renewed in 1920. Prof. Meek concludes, from an examination of the rings on the otoliths of the plaice, that the spawning season of 1917, and probably also that of 1916, was a poor one, and that the fry resulting from it were subjected to unfavourable conditions. He thinks that this may perhaps be due to the flooding of the inshore waters with oil, which occurred in the war, during the pelagic period of the eggs and fry. The trawling investigations of 1920 are compared in detail, especially as regards plaice, with those carried out before the war, from 1892 to 1913, and an account is given of the results of marking experiments made with the same fish. An interesting discussion on the migrations of the plaice and other fishes in the area is added. The important feature of the remainder of the Report is Mr. Storrow's paper on herring shoals. Samples from shoals extending from Stornoway and the Shetlands in the north to Yarmouth in the south were analysed as regards age and maturity, and samples of Irish fish were treated in the same way. Attention is directed to the fact that herrings in their fourth year form the most important constituent of the summer fishery along the east coast of Britain, and the author concludes that the fluctuations in this fishery depend largely upon the success of the spawning and rearing of the season four years before that of fishing.

IRISH ESKERS.—Mr. J. de W. Hinch, in a paper on "The Eskers of Ireland" (*Irish Naturalist*, vol. xxx p. 137, 1921), criticises the recent memoir by Prof. J. W. Gregory (*Phil. Trans. Roy. Soc.*, Section B, vol. ccx.), in which it is maintained that a large part of Ireland was submerged under the sea during the formation of the boulder-clay that now occupies the plainland. Mr. Hinch points out that this revival of an old view, which was very natural in its day, ignores the work done in glacial geology in Ireland for the last thirty years. If it is necessary, as some writers think, to regard eskers as deposited in water, a lake must be postulated; but the problem of the marine shells found in abnormal positions has been successfully met without demanding a submergence, in accordance with the widening of our knowledge of the behaviour of "continental" ice-sheets.

THE POST-GLACIAL CLIMATIC OPTIMUM IN IRELAND.—Mr. J. de W. Hinch, of the Geological Survey of Ireland, has recently discussed "The Post-Glacial Climatic Optimum in Ireland" (*Irish Naturalist*, vol. xxx. p. 85, 1921). He regards the warm damp epoch when the Littorina sea prevailed in the Baltic area as representing an optimum which declined towards present-day conditions. The hazel, for instance, had then its most northern fossil boundary, and regions of high arctic vegetation became sub-arctic. The oak and the elm have now a more southerly limit than at this optimum. Mr. Hinch now shows that the marine fauna of the estuarine days, overlying submerged peat on so many parts of the Irish cost, contains a number of molluscan species that have similarly migrated southward, but which were formerly present in abundance in a more northern habitat. The improvement in climate at the epoch of the submergence which gave us the estuarine clays may thus be regarded as an optimum, or near an optimum, which has not been maintained in more recent times.

LABRADOR AND NEW QUEBEC.—Memoir 124 of the Geological Survey of Canada, by Prof. A. P. Coleman, deals concisely with the "North-eastern part of Labrador, and New Quebec," and will be useful to geographers who wish to gain an insight into a territory that embodies many late glacial features, though it lies on the latitude of the Orkneys. The landscapes in the Memoir are excellent, and among them there is an example of the most puzzling feature of solifluxion in cold tundra lands, where the polygonal areas of soil become surrounded by walls of stones coarser than the average in the soil. As the author remarks, the effect produced is "as if the finer materials, sandy or gravelly rather than muddy, ascended and spread out from the centre, crowding the coarser blocks to the edge." No stratæ intervene in N.E. Labrador between sediments that are probably Huronian and glacial deposits that are referable to an early stage of the Pleistocene ice-age. The later glaciations from the Labrador centre seem never to have reached the Atlantic coast. The raised beaches occur below the 400 ft. contour-line, and are attributed to the depression of the land by the continental ice, which here was probably only 2000 ft. in thickness. Prof. R. A. Daly's study of the post-glacial warping of the region immediately to the south, including Newfoundland, was published in the *American Journal of Science*, vol. cci. p. 381, 1921, and in it he corrects previous statements, referred to by Prof. Coleman, that raised beaches occur in Newfoundland above 500 ft. The famous

labradorite-rock of Paul Island comes within the area described by Prof. Coleman. For this, Sterry Hunt's unfortunate name anorthosite is retained; even so acute a recorder as Dr. A. Holmes has been led astray by this term, and has stated that anorthose is the French equivalent for plagioclase.

SULPHUR IN ILLINOIS COAL-BEDS.—The University of Illinois Bulletin, vol. xviii. No. 36 (Bulletin No. 125) contains the results of an investigation by Messrs. H. F. Yancey and Thomas Fraser upon the mode of occurrence of sulphur in certain of the coal-beds of Illinois. It is shown that the sulphur is present partly in the form of pyrites and partly in certain organic compounds; the former may be either macroscopic or microscopic. The technical importance of these distinctions lies in the fact that it is practically only the sulphur present in macroscopic pyrites which can be separated by washing. In some cases a certain amount of sulphur is present as sulphates, but there were only traces of these present in the coals examined. Pyritic sulphur is characterised by extreme irregularity of distribution in the coal-bed, mainly due to the concentration of the pyrites in coarse bands or lenses. On the other hand the vertical distribution of organic sulphur is comparatively uniform at given points in the same bed, though in the mine as a whole the variations may be considerable; nevertheless it is more uniformly distributed than pyritic sulphur. There is no definite relation between the occurrence of organic and pyritic sulphur. The amount of the former is quite important, the percentages in three mines being :—

	I.	II.	III.
Pyritic Sulphur . . .	47·3	47·7	60·5
Organic Sulphur . .	52·7	52·3	39·5

In 104 face samples taken in the three beds, organic sulphur exceeded pyritic sulphur in 49 samples.

EVAPORATION FROM LARGE EXPANSES OF WATER.—This subject is dealt with in the *Meteorological Magazine* for January and February. In the January issue reference is made to Dr. H. Jeffreys, who submitted the problem to mathematical analysis in 1918, and who adopted the simple hypothesis that the rate of evaporation depended only on difference of vapour pressure. It is mentioned that Mr. M. A. Giblett in *Proc. Roy. Soc.* A, vol. 99, 1921, makes a further advance by allowing for the strength of the wind. Valuable information is given as to the total amount of evaporation under various circumstances. It is asserted that the same amount of air picks up less moisture if it crosses the ocean quickly than if it goes slowly; the more vigorous evaporation does not make up for the shorter time of passage. The February *Meteorological Magazine* deals with "The Evaporation from the Sea," by G. Wüst (Institut für Meereskunde, Berlin, Oct. 1920). This publication was taken for discussion at the Meteorological Office at the evening lecture on February 6 last. An estimate is given of the zonal distribution of evaporation, which is said to be most rapid between the latitudes 10° and 20° north and south. Comparison between the estimates of evaporation and the rainfall over the ocean indicates that evaporation exceeds precipitation between latitudes 40° N. and 40° S., except in the cloudy equatorial belt, whilst outside these limits precipitation is in excess of evaporation.

METEOROLOGY IN MEDICINE.—At a meeting of the Royal Meteorological Society in the University, Edinburgh, on September 7 last, a paper on Meteorology in Medicine, with especial reference to the occurrence of malaria in Scotland, was read by Dr. Angus G. Macdonald. The paper is printed in the Quarterly Journal of the Royal Meteorological Society for January. Meteorology is described as a science, and medicine as a consummate art—the practical exploitation of the data of all the sciences for the conservation of mankind. Referring to the re-appearance of malaria indigenous in England in the years 1917, 1918, and 1919, temperature results are given for the months of June–September in each year. It is mentioned that it would appear to be safe to infer that any month having a mean temperature of 60° F. may suffice to produce malaria in England, given other conditions favourable. The conditions in the years mentioned were associated with the presence of a large mass of infection imported in soldiery from the East. The recent period of malaria is contrasted with the last previous recorded outbreak of malaria in England in the years 1856–59, when a period of abnormally high temperature is shown to have occurred. This period also coincided with the return of infected soldiery from Eastern Europe, this time from the Crimean War. An abnormally cold year followed in 1860 which brought the infection to an end. In relation to the maturation of the infection especial reference is made to the mosquito associated with high temperatures. These general considerations are applied to occurrences of malaria in Scotland, and much valuable information is given.

INDUSTRIAL LIGHTING.—In a paper read before the Illuminating Engineering Society on February 28, Mr. L. Gaster discussed "Ideal Requirements in Industrial Lighting and Practical Solutions." Ideal lighting conditions should enable work to proceed by night as safely and efficiently as by the best daylight. Practical possibilities were illustrated in the recommendations of the Home Office Departmental Committee on lighting in factories and workshops and the codes of industrial lighting adopted in various American states. The latter, while more detailed and elaborate, were based on the same general principles, namely, sufficient illumination, avoidance of glare, and elimination of inconvenient shadows. Mr. Gaster laid stress on the fact that sufficient illumination was only part of the problem. A distinction must be drawn between recommendations and legislative measures. Any form of code must be so framed as to prevent abuse of industrial lighting and yet impose no hardship on manufacturers. The Home Office in this country had proceeded wisely step by step, adopting the principle of "government by consent." Their first report, besides recommending general statutory provision requiring adequate lighting, proposed certain values of illumination, easily obtained, in the interests of safety and general convenience. Their second interim report proposed a simple rule for avoidance of glare, which could be met in various ways. In future it was intended to study values of illumination and conditions of lighting necessary for efficient work in various industrial processes, co-operation being invited from representatives of the industries concerned. This process might take some time, but would ensure decisions being taken on a sound and scientific basis. In conclusion Mr. Gaster mentioned that industrial illumination was becoming a subject for international treatment. It was being considered by an international committee appointed at the recent technical session of the International Illumination Commission, and it was also receiving attention from the International Labour Office operating under the League of Nations at Geneva.

Carbon Monoxide in Gas.

By PROF. JOHN W. COBB.

THE following paragraph appeared in *The Times* for February 11, under the heading "Carbon Monoxide Peril."

"The Board of Trade has drafted a special Order under the Gas Regulation Act, 1920, relating to carbon monoxide in gas used for domestic purposes. The Order provides that: No gas undertakers as defined by the Gas Regulation Act, 1920, shall supply any gas for domestic purposes containing carbon monoxide unless such gas possesses the distinctive pungent smell of coal gas. The Order requires the approval of both Houses of Parliament."

The announcement needs some explanation, as probably nobody in this country has ever come across a public gas supply without a very distinctive and pungent smell.

When Sir George Beilby and the Fuel Research Board were called upon by the Board of Trade, some time ago, to make recommendations for the future regulation of public gas supply, they recognised in effect that radical improvements and economies by the gas manufacturers could be secured by the gasification of the fixed carbon of the coal by some such process as that of the steaming of vertical gas retorts or the gasification of coke in external generators with steam—the so-called water-gas process.

The increase in the carbon monoxide content of the gas so involved depended upon the extent to which the fixed carbon was gasified. The recommendations then made form the basis of the Gas Regulation Act of 1920, but when the Act was passed it was decided that the Board of Trade should institute inquiries on two special points, one of which was "whether it is necessary or desirable to prescribe any limitations of the proportion of carbon monoxide which may be supplied for the gas used for domestic purposes." The inquiry was made and evidence taken by a Committee from witnesses who regarded this matter from different points of view, and set out their arguments at length. It became plain that the economic advantages offered by the new Act depended very largely on freedom to supply gas containing more carbon monoxide, and that even on the side of hygiene the position was not so simple as might appear at first sight. Any danger from carbon monoxide had to be placed against the improvement of public health which would result from the progressive abolition of smoke as gas replaced raw coal for heating purposes, and it had to be realised that in no circumstances would it be practicable to supply gas containing little or no carbon monoxide, since ordinary "straight" coal-gas might contain 10 per cent or more.

It is not surprising, therefore, that the Committee recommended against statutory limitation of carbon monoxide in public gas supply. It was, however, possible that the conditions of manufacture might at some time or place be changed to such an extent that the gas then supplied to the public would be nearly odourless unless some means were taken to confer a smell upon it, and to meet that possibility of the future it was recommended that the distribution of an odourless gas should be made an offence.

The Board of Trade Order, which has just been drafted, will carry that recommendation into effect. It is no doubt hoped that it will also have on the public mind the beneficial effect of a psychological antitoxin, which seems to be needed at the present time.

During the last two months of severe weather, the number of accidents from gas poisoning undoubtedly increased. Various factors have been operative in bringing this about, including the tendency to restrict ventilation owing to the cold, and to use gas heating appliances of all kinds, in all sorts of places, and particularly in bedrooms. Public attention, however, having been directed to the fact that carbon monoxide in public gas supply might increase considerably in the future owing to the Gas Regulation Act, people have arrived at the mistaken conclusion that such increase had already taken place and was solely responsible for these accidents. It would, as a matter of fact, greatly surprise the present writer to learn that the carbon monoxide content of gas responsible for any one of these accidents was above the permissible limit recommended by the advocates of restriction before the special Committee to which reference has been made above. In the gas supply of Leeds, which has come under the writer's own tests, the percentage of carbon monoxide has been actually considerably lower than it was during the summer months of the coal strike, and no higher than in the preceding winter. Nor is there any reason to suppose that the condition so described is exceptional.

The Brain of Rhodesian Man.

AT a meeting of the Royal Anthropological Institute held on February 14, Dr. W. H. R. Rivers, president, in the chair, Prof. G. Elliot Smith described the brain of Rhodesian man.

The excellent endocranial cast which Mr. Frank Barlow, of the Natural History Museum, has been able to obtain from the Rhodesian skull is of exceptional importance. In the first place, it affords evidence which settles once for all the position of *Homo rhodesiensis* in the human family and its varying degrees of affinity to the different members of the family; and, secondly, it provides very precise information concerning the size, shape, and stage of development of the brain of Rhodesian man, so that when the endocranial casts of Pithecanthropus, Eoanthropus, and *Homo Neanderthalensis* are compared with it and the whole series is considered in the light of the new information, a fuller understanding of the process of evolution of the human brain is attained. Moreover, the endocranial cast enables us definitely to settle the dispute as to the posture of Rhodesian man, or at any rate as to how he carried his head.

Prof. John Hunter, of the University of Sydney, has made a series of exact orthogonal projections of the endocranial casts of the extinct types of the human family and of the anthropoid apes, and has shown that Rhodesian man's head was thrust forward on his tremendously massive neck at an angle almost exactly intermediate between that of the gorilla and modern man—a degree of obliquity almost identical with that of Gibraltar man and probably a little more than that of the man of La Chapelle-aux-Saints. The peculiarly distinctive features of the base of the skull of Rhodesian man corroborate this interpretation. The cranial capacity is 1280 c.c., which is roughly equal to that of the Gibraltar skull, but much smaller than all the other members of the

Neanderthal species. It is definitely bigger than the Piltdown cast.

Like the endocranial casts of Pithecanthropus and Eoanthropus, that of the newly discovered skull reveals a marked deficiency in the prefrontal and inferior temporal areas. But as in all these primitive members of the human family, there is an obtrusive prominence in the auditory territory which suggests that the cultivation of the acoustic symbolism necessary for the acquisition of articulate speech was a very important, if not the dominant, factor in the attainment of the human status. This localised expansion in the superior temporal area is responsible for the peculiar form of all primitive human brains, *i.e.* their relatively great width and flatness. The expansion of the cortex has been carried a stage further than in the Piltdown brain and has led to a fuller development of the inferior parietal territory, but the superior parietal area is still ill-developed and flat.

Thus the Rhodesian cast reveals a stage definitely more primitive than that of Neanderthal man and helps us to understand the features of the latter. The significance of the peculiarities, so far as they shed light upon the evolution of the human brain, was discussed, and the speaker expressed his gratitude to Dr. Smith Woodward of the British Museum for affording him the opportunity for studying the Rhodesian skull and the endocranial cast obtained from it.

The president, in opening the discussion, said that he had been particularly struck by the demonstration of the development of those parts of the brain that are connected with mind, and it was interesting to note that those parts which were latest in development of the child were those in which Rhodesian man stood intermediate between the gorilla and modern man.

Dr. Smith Woodward regretted the absence of geological or palæontological data which might throw light upon the age of the skull. Any attempt to determine its age must depend upon the character of the skull itself. Prof. Elliot Smith had made a beginning of the scientific study of this evidence, and it should be possible to determine its position in the human series apart from geological evidence. Prof. W. Wright said that Prof. Elliot Smith had given a clear demonstration of the development of the brain from the lowest primates to Dean Swift. Would it not be possible to go a little further and prophesy that the future development of the brain would be in the direction of filling those parts of the cranial cavity which were at present ill-filled? He agreed that the author was justified in now placing Pithecanthropus definitely within the human family. Prof. Parsons said that the present communication indicated the value of the endocranial cast in ethnological investigation, and that this method of study should be applied to the investigation of the problems connected with modern races.

Evolutionary Faith and Modern Doubts.

In a notable address on the above subject at the Toronto meeting of the American Association for the Advancement of Science, which is printed in *Science* for January 20, Dr. William Bateson discusses particularly the changes in point of view which have followed each other since the Darwinian period and the end of last century. The morphological school worked itself out, and was followed by the development of genetic experiments. It was seen that the gradual transformation of species over large areas was an unacceptable doctrine. From field studies of pairs of species it was concluded that both could not have come from an intermediate ancestor through gradual divergence by natural selection, nor could either have given rise to the other by such a process.

Then Mendelism seemed to furnish an explanation of the discontinuity of species—a discontinuity which had long been denied by those evolutionary philosophers who were not systematists. Nevertheless, the result has been disappointing, and the attempt to explain evolution in Mendelian terms has finally been dropped. This is because evolutionary conceptions have dealt with zygotes, or the bodies of plants and animals as we see them, while genetic research has revealed the interactions of an inner world of gametes upon which the zygotes depend for their origin. Dr. Bateson further records his full conversion to the belief that the chromosomes are directly associated with the characters of the zygote. "The transferable characters borne by the gametes have been successfully referred to the visible details of nuclear configuration."

Although we see variations in abundance on all hands, the origin of species is still obscure, and genetic analysis has not enabled us to account for certain phenomena, especially the origin of new dominant characters and of sterility. The question of species-origin is believed to be concerned with the base upon which transferable characters are implanted, but of this base we at present know nothing. Dr. Bateson concludes a remarkable survey with an appeal for closer co-operation between geneticists and systematists, and finally points out that the fact of evolution is not in doubt, although the manner of the origin of species remains a mystery.

R. R. G.

The Teeth of the Nation.[1]

The lecturer began by directing attention to a series of skulls exhibited, kindly lent for the occasion by Sir Arthur Keith. Skulls of Neolithic date showed perfect dentition, though the teeth were worn a good deal by attrition; the skulls of to-day exemplified the ravages of dental caries, or of the equally prevalent disease of gums and jaws called pyorrhœa. One modern skull with a perfect set of teeth was the rarest specimen he could show. Caries was not unknown in past ages, and even the teeth in the Rhodesian skull exhibit it. The seriousness of the increase in dental decay in recent times is such that the Ministry of Health has appointed a special Committee to investigate its causes and prevention. Cleanliness is a necessary duty, and the tooth-brush, unless supplemented by antiseptic mouth-washes, is an imperfect instrument. The danger is the accumulation of food-débris in chinks and crevices and the formation of acids such as lactic acid by bacteria, especially if the food is soft and sticky and contains easily fermentable sugars of the glucose type. Such acid has a solvent action on the protective layer of enamel, and in time on the dentine which it covers.

The teeth, however, are not mere ornaments to be

[1] Abstract of a discourse delivered at the Royal Institution in February 10 by Prof. W. D. Halliburton, F.R.S.

kept clean locally. They are living structures, and their power of resistance varies with the general health, and this, like the health of the teeth, mainly depends on a supply of natural foods in proper quantity, especially in early life when tooth-formation occurs. Early life means especially embryonic life, and the proper feeding of expectant mothers is a *sine qua non*. Sophisticated and patent foods are specially harmful, for they, as a rule, lack the necessary "vitamins," which were then described in outline. Bad teeth in their turn undermine the general health, and, by forming foci of infection, lead to general ill-health, indigestion, blood-poisoning, rheumatoid affections, and the like, and so a vicious circle is produced, the abolition of which becomes a national duty.

After a general account of what is called "calcium metabolism," a series of lantern-slides was shown to illustrate not only the structure of the various parts of a tooth, but also the stages in their development, in which the cells responsible for the elaboration of the enamel prisms and the layers of dentine with its tubules and the nerves, etc., within them were seen. Occasion was taken to press home again the possibilities of injury and the necessity for care, especially in early stages and in early life, the word "early" including fœtal life. In conclusion, the lecturer looked forward to a time in the not far distant future when the teeth of the nation might be its pride, and not a source of lamentation and pain.

The Brown Bast Disease of the Para Rubber-tree.[1]

By DR. S. E. CHANDLER.

DURING the early years of rubber planting in the East considerable optimism prevailed in certain quarters as to the powers of the Para rubber-tree (*Hevea brasiliensis*) to resist disease in its new home. The planting of such great areas with a single crop plant, however, was practically certain to result sooner or later in fungal disease, to say nothing of insect attack; and, although little was (and still is) known as to the functions of latex in plants, it was safe to predict that the regular withdrawal of considerable quantities of latex from the trees would result in physiological disturbances which might become a factor of commercial importance. Events have proved these views to be well founded. As compared with many crops, rubber has been comparatively free from visitations, but several fungal diseases are now recognised and insect pests are not unknown; while a disease hitherto ascribed to physiological causes, and known as "brown bast," has attained such importance as to constitute the most dangerous cultural menace to the rubber-planting industry at the present day.

Brown bast is a disease of the bark[2] of tapped trees, but it does not involve the death of the tree, or even of the affected bark. The disease may be recognised by a difficulty in obtaining latex on tapping to the usual depth, followed ultimately by the cessation of latex flow (when the tree is said to be "dry"), and is further characterised by a brownish or olive-green discoloration of the middle and inner bark, which may show a definite brown line on the tapping cut near the cambium. External signs of the disease may be lacking, but in the more severe cases the outer bark often scales and splits longitudinally and an exudation of latex occurs. This condition sometimes results from the secondary development of woody "burrs," nodules, or plates within the diseased tissue, and, unless the case is dealt with, these bodies may cause the bark ultimately to become so knotted and irregular as to be useless for tapping purposes. The formation of burrs and nodules, however, is not necessarily associated with brown bast, as has been shown by Bateson, Bryce, and others.

Brown bast was widely reported as an epidemic in the plantations during 1916–18, and a satisfactory method of treatment became a matter of prime importance. Pending exact knowledge as to the cause of the disease, the methods recommended were based on the observations that affected latex-vessels do not again function, that the diseased portion of the bark is useless for further tapping, and that the disease "spreads" in the bark. Planters were therefore advised to remove the diseased tissue, either by "scraping" the brown bast tissue from the bark, or by carefully "stripping" off the bark down to the cambium. In the latter case, especially, measures should be taken to protect the delicate exposed surface so that a satisfactory regeneration of the bark by the cambium may take place. The removal of the superficial layers of the affected bark, followed by the application of warm tar to the exposed surface, has also been practised.

It was early recognised, however, that the best chance of devising adequate measures of control would result from a correct understanding of the nature of the disease, and considerable research on this subject has been carried out by British and Dutch botanists in the East. So far, attempts to associate the disease definitely with bacterial or fungal attack have failed, and at the present time brown bast cannot be ascribed to any causal organism, though it has been claimed by Keuchenius that bacteria are present in the diseased tissue. With the bulk of evidence against a parasitic origin of the disease, most investigators have fallen back on the theory that brown bast is a physiological disease, the result of metabolic disturbances as to the nature of which, however, little or no information is available.

Recently a series of important publications on the etiology of brown bast have appeared almost simultaneously. The results obtained are of exceptional interest, inasmuch as the work has been carried out by investigators widely separated and working independently on material derived from several different planting countries. Rands (1) and (2) has dealt with the disease in Java and Sumatra; Sanderson and Sutcliffe (3) in British Malaya; Gandrup (4) in Java; while Farmer and Horne (5) and (6), in London, have examined diseased material from British North Borneo and Malaya. These in-

[1] (1) "Brown Bast Disease of Plantation Rubber, its Cause and Prevention." By R. D. Rands. Mededeelingen van het Instituut voor Plantenziekten, Departement van Landbouw, Nijverheid en Handel, No. 47 (1921); overgedrukt uit her Archief voor de Rubbercultuur, Jaargang V., No. 5 (Mei 1921).
(2) "Histological Studies on the Brown Bast Disease of Plantation Rubber." By R. D. Rands. Mededeelingen van het Instituut voor Plantenziekten, Departement van Landbouw, Nijverheid en Handel, No. 49 (1921).
(3) "Brown Bast: An Investigation into its Causes and Methods of Treatment." By A. R. Sanderson and H. Sutcliffe. Pp. 71+26 plates. (London: The Rubber Growers' Association, Inc., n.d.) 7s. 6d. net.
(4) "Over den Steencellenring in de Schors van Hevea." Door Johannes Gandrup. Mededeelingen van het Besoekisch Proefstation, Rubberserie, No. 19 (1921); overgedrukt uit het Archief voor de Rubbercultuur, Jaargang V., No. 9 (September, 1921).
(5) "On Brown Bast and its Immediate Cause." By J. B. Farmer and A. S. Horne. *India-Rubber Journal*, vol. 61, No. 25, June 18, 1921.
(6) "Phloem Necrosis (Brown Bast Disease) in *Hevea brasiliensis*." By Arthur S. Horne. *Annals of Botany*, vol. 35, No. 139, July 1921.
[2] The term "bark" is here used in the planter's sense of the tissue actually involved in the tapping operation.

vestigations throw much light on the anatomy of the diseased tissue and the probable immediate cause of brown bast, while in the case last mentioned it seems probable that a valuable advance has been made towards a correct understanding of the nature of the disease.

The two papers of Rands (1) and (2), who published preliminary reports in 1919 and 1920, are complementary. The first-mentioned paper contains a full statement to date of the results of the author's investigations commenced in 1918 at the instance of the Director of the Government Rubber Estates in the Dutch East Indies, and still in progress. Rands's results support the view of the non-parasitic origin of the disease, and indicate that the repeated withdrawal of the latex from the same tissues is the chief causal factor concerned. The drained tissues respond by secreting a gum, which in its effects prevents a further loss of latex. The time-interval between successive tappings and the system of tapping adopted appear to be the most important predisposing factors; in the author's experience a heavy occurrence of the disease is invariably associated with a drastic system of tapping. The second paper records the botanical (anatomical) evidence on which the results are based. According to Rands, brown bast appears to be a special type of wound-gum secretion favoured by conditions which promote the vital activity of the tree. The characteristic brown discoloration of the diseased bark is stated to be due to the deposition of a yellow plastic "gum" in the cavities of the latex-vessels and in many of the intercellular spaces of the bark (phloem) parenchyma, thus recalling similar observations made by Bobilioff.

The gum is formed, not by the breaking down of cell-walls, but as a secretion of the protoplasts of the parenchymatous cells adjacent to the latex-vessels. It passes into the latter through the common cell-wall (which is thereby stained yellow), and also into the existing intercellular spaces or into such spaces formed and enlarged under the stimulus of the secretion. It is secreted in largest quantities during the wet season, and is most abundant in vigorous trees in full growth. Investigation showed that the gum is practically identical with the "wound-gum" formed locally as a result of artificial wounds made in the wood and bark of the tree, and is similar to the corresponding product in other plants. It differs from the true gums, however, in its chemical reactions. The clogging of the latex-vessels appears to be the chief factor in arresting the latex flow, but the coagulation of the latex within the vessels is also indicated as a contributory factor. Under the highest powers the gum is seen to possess a well-marked alveolar structure which is not an artefact. Rands was unable to determine whether the gum-formation results from enzyme action, as has been suggested in the case of the gummosis of Prunus. As regards the burrs, Rands's results in general confirm the previous work of Rutgers, Bateson, Bryce, and others, and especially the suggestion of Bateson that burr-formation is favoured by excessive tapping. The woody burrs arise from the activity of a secondary cambium formed about a group of gummed latex-vessels; the varied form of the mature structure (pea-shaped, knobby, or plate-like) depends upon the disposition and extent of the secondary cambium.

The book by Sanderson and Sutcliffe (3) is primarily intended as a practical guide for estate managers in diagnosing the disease and in treating affected trees. The authors lay special emphasis upon the desirability of early treatment, and recommend "stripping" of the bark, not only as curative in effect, but also as the simplest and cheapest procedure. A considerable portion of the book, however, is devoted to the results of a microscopical study of the disease, and the authors claim their work to be the first attempt to describe the pathological anatomy of brown bast and to formulate a theory by which the observed facts may be explained. They regard brown bast as physiological in origin, and consider tapping to be its prime cause. As regards pathological anatomy, Sanderson and Sutcliffe find that the constant and characteristic feature is a meristematic activity of the parenchyma cells of the bark. Other characters described by them, viz. the deposition of "tannins" and crystals of calcium oxalate, the occurrence of abnormal numbers of stone-cells at unusual depths in the bark, the depletion of starch, and the presence of globules of "oil or fatty matter" (suggested possibly as a substitution product for starch, or as the result of a breaking down of that substance), are regarded as secondary symptoms arising from the meristematic activity.

Elsewhere, however, the authors state that the occurrence of "tannins" is not characteristic of the disease, while large numbers of oily globules are not constantly present. The meristematic tissue originates at a point roughly corresponding to the depth of tapping, and occurs almost invariably in the immediate vicinity of the latex-vessels. The result is a partial displacement of these vessels, which, in consequence, are often ruptured, the latex percolating into the intercellular spaces, where it coagulates. The latex within the vessels also appears to be coagulated *in situ* (*cf.* Rands), possibly through the agency of the by-products of the metabolism of the actively dividing cells. The coagulated latex is considered to be an additional source of irritation, stimulating the surrounding tissue to further meristematic activity.

The views put forward by these authors as to the immediate origin of the disease are interesting. They consider that the abnormal meristem may be due to the stimulus arising from the wound meristem formed just beneath the surface of the tapping cut, or it may be a secondary effect of the abnormal vigour of the cork cambium which early arises over the previously tapped surface to form the renewal bark. Sanderson and Sutcliffe regard it as "highly probable" that the growth of this cork cambium "provides the stimulus for starting meristematic activity at an equal, or almost equal, depth in the cortex below the tapping cut, *i.e.* in the untapped portion of the cortex below." Such induced cambial activity spreading from the renewal bark was first described by Lock, but it is not quite clear from the present paper whether Sanderson and Sutcliffe have independent evidence of a similar phenomenon in the case of brown bast.

As regards burr-formation, the case is put that, while the meristem of brown bast may remain as such, it may also give rise to woody tissue internally and unlignified elements externally. It is in this latter manner that burrs originate, and the degree and character of the burr-formation depend upon the amount and disposition of the meristem concerned. Sanderson and Sutcliffe ascribe considerable importance to the production of stone-cell tissue as a secondary character of brown bast. In this respect they are supported by other writers. The cells on the outer limits of the meristem may be largely converted into stone-cells, which sometimes form extensive scleritic masses resulting in the scaling of the outer bark. The observations of Gandrup (4) are interesting in this connection, since this worker shows that in the young Hevea plant the stone-cells arise among the thickened prosenchymatous pericycle fibres (bast fibres), which later are almost completely replaced by a ring of stone-cells.

The papers of Farmer and Horne (5) and (6) give the results of a research carried out in the botanical laboratories of the Imperial College of Science and

Technology on material received from British North Borneo and Malaya. The work formed the subject of an exhibit at the Rubber Exhibition of 1921, and was briefly noticed in NATURE of June 16 last, p. 499. It is understood that further work is in progress, and that a full illustrated account of the results will be published. These authors have concentrated attention upon the earliest stages of the disease, and obtained results which definitely advance the problem a step towards solution. In transverse sections of diseased bark, numerous minute golden-yellow spots of irregular outline were observed in the phloem from the cambium outwards. Under high magnification these coloured areas sometimes appeared to resemble intercellular spaces (*cf.* Rands's work), but on careful examination the golden areas were found to be sections of necrotic *sieve-tubes*, the waved outlines in many cases being clearly transverse sections of the large vertical sieve-plates characteristic of Hevea phloem. In the young phloem the disease is confined to the sieve-tubes, but in the older tissue phloem parenchyma, medullary-ray cells and latex-vessels have been involved in the local tissue degeneration. Commonly, a diseased area was found to be more or less completely surrounded by an active meristem (" wound-cambium "), which in some cases gave rise to lignified elements and constituted the initial stages of a burr.

It will be seen that this investigation emphasises the fact that, quite apart from the latex-vessels, elements (sieve-tubes) of vital importance in the nutritional processes of the plant are injured during tapping. The sieve-tubes cease to function and, in becoming disorganised, initiate the condition known as brown bast. The disease, therefore, is primarily due to phloem necrosis analogous to the cases of similar disease reported in the potato and in Liberian coffee. Observations were also made regarding the origin of burr development. It is stated that, as a result of the activities of the wound cambiums, diseased groups of cells become enclosed in " pockets " of stone-cells. Sanderson and Sutcliffe also refer to stone-cells derived from the pathological meristem in the bark tissue.

In reading this series of papers for the first time it is difficult to believe that the authors are dealing with the same problem. No evidence for a parasitic origin of the disease is brought forward in any case, but their respective investigations lead the authors to differ in their views as to the immediate origin of the disease. Sanderson and Sutcliffe point to an induced meristematic activity in the bark as the characteristic feature of the pathological anatomy. To Rands the disease is a special case of gummosis which is the outcome of a wound response resulting from tapping; while Farmer and Horne regard phloem necrosis as, " beyond doubt," the immediate cause of the disease. The present writer carefully examined Horne's remarkable preparations and camera-lucida drawings shown at the Rubber Exhibition last year, and recently he has been allowed to compare further the drawings with the illustrations accompanying the papers of Rands and of Sanderson and Sutcliffe. He considers that the true relations of the seemingly conflicting results are apparent on the view that a difficult piece of anatomy has been carried out to varying degrees of finality by the respective workers. In the case of Horne's work there is little doubt that his investigation has shown that the immediate cause of brown bast is a degeneration of the sieve-tubes and neighbouring elements, accompanied by the more or less complete localisation of the necrotic area by an active meristem. Rands's research appears to have fallen just short of complete success. In spite of his histological methods to prove his " intercellulars " to be such, comparison of his drawings with those of Horne strongly suggests that they are the necrotic sieve-tube areas illustrated by the latter worker. It is remarkable that throughout Rands's anatomical paper he uses the word " sieve-tube " twice only, though in the only diagram in which sieve-tubes appear each of the two sieve-tubes figured is blocked with " gum." Rands's view that the disease is a type of " gummosis " is by no means beside the mark; it may well be so regarded in its ultimate symptoms, but he failed to detect the primary cause. The abundant meristematic activity emphasised by Sanderson and Sutcliffe would appear to be a secondary character, and is possibly a development of the pathological meristem referred to by Farmer and Horne. It may be significant in this connection that the bark examined by Sanderson and Sutcliffe was from trees which " had been taken out of tapping for some little time owing to brown bast," and in which, therefore, there may have been time for the meristem to reach considerable development. The suggestion that the pathological meristem is formed as a result of the stimulus afforded by the activity of the cork-cambium of the tapped bark above the diseased area is interesting, and the authors might usefully have given further evidence in support of the contention.

There would appear to be some difference of opinion as to the condition of the starch reserves in the diseased bark. Sanderson and Sutcliffe report that starch is usually absent, or present in small quantities only, and regard this depletion as accounted for by the demands for food materials made upon the neighbouring tissue by the meristematic cells. Rands, however, states that evidence based on observations of the starch reserves indicates that the response of the tissues, resulting in the " disease," is more the effect of a stimulus connected with a loss of latex than of an actual depletion of (starch) reserve food, though he suggests the possibility of effects caused by the temporary depletion of other food substances, *e.g.* the proteid constituents of the latex which are known to suffer a reduction as the consequence of hard tapping.

If the initial occurrence of phloem necrosis is confirmed, there will remain the problem of the cause of this condition. The solution of the problem is inseparably connected with the general question of phloem necrosis in plants. Thus light may be thrown on brown bast by the recent work of Quanjer, who claims that phloem necrosis in the potato can be transmitted from one plant to another.

As pointed out by Farmer and Horne, the current investigation of brown bast disease points clearly to the urgent need for a wider understanding of the general physiology of Hevea, in which, of course, the laticiferous system would call for special attention. The present writer ventures to suggest that before this question (of which little is as yet known) can be dealt with successfully, it is essential that fuller knowledge of the anatomy and histology of laticiferous tissue in general should be available. Useful pioneer work has been done by Meunier, but the papers under review show how far from complete such knowledge is at present in the case of Hevea alone. There is little doubt that, as in zoology, *comparative* anatomy would be highly suggestive and helpful. The study should extend at least to carefully selected arboreal laticiferous plants, of which the various " rubber-trees " which have been cultivated or exploited commercially would probably be sufficient, since the character of their laticiferous systems varies greatly in important features. The essential

difference between the laticiferous systems of Hevea and Funtumia, and the presence in Castilloa, Funtumia, and Landolphia of a striking development of laticiferous tissue in the xylem (medullary rays), connecting the latex-tubes in the phloem radially with those in the pith, are but instances of a significant state of affairs. A thorough study of this question could not fail to lead to important scientific knowledge which, in competent hands, might well result in practical applications. Again, such striking facts as the occurrence in *Funtumia elastica* of an excellent latex rich in caoutchouc, while in the closely related *F. latifolia* (often found growing with the former species) there is a commercially useless latex containing abundant "resins" in place of caoutchouc, present problems, difficult indeed, that might well receive more attention at the hands of biological chemists. The preliminary anatomical work would be best carried out in the tropics, but with a little organisation much might be accomplished in this country, as is evident from the fact that observations which may prove to be the key to the correct understanding of a baffling disease of Hevea have recently been made in London.

Dairy Cattle and Milk Production.

THE urgency of the problem of milk supply has of late years caused much attention to be devoted to the improvement of dairy cattle, and to the increase of milk supply on an economic basis. During the last twenty-five years the Danish Milk Recording Societies (*Journ. Min. Agric.*, October and November 1921) have been working towards the improvement of herds by the gradual elimination of unproductive cows, and Government grants have been made to aid them in the formation of strains of dairy cattle producing a higher yield of butter. The keeping of private and official handbooks is encouraged, and a special feature is made of two-year competitions between entire herds, the best herds being awarded prizes and officially recognised as breeding centres. The earlier work dealt entirely with the yield of cows, but later it was realised that the character of the bull was of equal importance with regard to milk production, as high milk-yielding capacity is a character that can be inherited through the sire as well as the dam. By close observation of records and careful breeding, attempts have been made to obtain bulls with a good influence on the milk yield, with considerable success. As Denmark is chiefly a butter-producing country, the main object of the milk-recording societies has been to raise the percentage of butter fat, thus aiming at improvement of quality more than at increase of quantity.

The milk problem is by no means confined to European countries, but various aspects of dairying are being investigated elsewhere, as in the Madras Agricultural College, India (Bull. No. 79). Special consideration is given to business aspects as well as to the technical methods of dairying. Approved methods of selection are applied to the dairy herd, unprofitable cows being weeded out, and pedigree registers are maintained. A creamery is also run for the preparation of butter on a commercial scale, milk being purchased from outside to supplement the home supply. The prospects of success are good, and a future seems to be before the dairy industry of India if it is managed with scientific and business knowledge.

One point which has a close bearing on dairy-farming is the varying cost of milk production, which has ranged from 3½*d.* to 4*s.* 7½*d.* per gallon since 1908 on Yorkshire farms for which records are available (*Scottish Journ. Agric.*, vol. 4, No. 4). Some of the factors concerned are not under the control of the producer, and are due to increase in the labour and food bills, and to the increased depreciation of the cows. In pre-war time the cost of attention per cow per week varied from 1*s.* 6*d.* to 2*s.*, but owing to the rise in agricultural wages it is now 4*s.* 6*d.* to 6*s.*, an increase which is estimated to have added 4*d.* per gallon to the pre-war cost of milk production. The cost of food has risen on every hand. Grazing is far more expensive owing to increased cost of manure and upkeep, home-grown food costs at least twice as much to produce, and, above all, purchased food has risen so much in price that it is probably the one factor more than any other which has been responsible for the high prices of milk during recent years. During the war, too, the difference in value between in-milk and dry cows greatly increased, and this depreciation in value has had its effect upon the cost of milk production. The tables drawn up indicate that in some cases the total costs have exceeded pre-war costs by 300 per cent., but happily there are indications that the inflated prices are easing off, and they show signs of being still lower in the near future.

W. E. B.

University and Educational Intelligence.

CAMBRIDGE.—The Smith's prizes have been awarded to E. A. Milne, Trinity College, for an essay on "Studies in the Theory of Radiative Equilibrium," and to G. C. Steward, Gonville and Caius College, for an essay on "The Aberration-Diffraction Problem." A Rayleigh Prize has been awarded to T. A. Brown, Trinity College, for an essay "On a Class of Factorial Series."

J. A. Carroll, Sidney Sussex College, has been elected to an Isaac Newton Studentship, and the Studentship of W. M. H. Greaves, St. John's College, has been renewed for a year.

Regulations have been proposed for the degrees of M.Litt. and M.Sc. The chief difference from the Ph.D. regulations are that a student must for these degrees do research for two years as against three for the Ph.D. The Board of Research Studies publishes its second annual report. There have now been 143 research students admitted, of whom 5 have already taken the degree of Ph.D. Of these 95 are working in scientific subjects—physics with 22, chemistry with 16, and botany with 12, head the list.

LONDON.—The under-mentioned French professors in the Faculty of Medicine of the University of Paris will lecture (in French) at the Rooms of the Royal Society of Medicine, 1 Wimpole Street, W.1, at 5 P.M., on the dates stated:—

March 20, Prof. H. Roger (Dean of the Faculty), "Les fonctions du Poumon"; March 23, Prof. A. Chauffard, "Syndrome Humoral de la Goutte"; March 27, Prof. P. Duval, "Données actuelles de la Chirurgie Intra-Thoracique."

PROF. H. R. DEAN has been appointed as from June 1 next to the University Chair of Bacteriology tenable at University College Hospital Medical School. Since 1915 Prof. Dean has been Professor of Pathology and Pathological Anatomy in the University of Manchester. He has been Horace Dobell Lecturer for the Royal College of Physicians, and is the author of numerous papers on pathological and bacteriological subjects.

Calendar of Industrial Pioneers.

March 16, 1864. Richard Roberts died.—A man of invention, whose genius did not save him from ultimate poverty, Roberts was the son of a Welsh shoemaker. He worked at various trades in different parts of England, and in 1816 settled in Manchester, where he made improvements in engineers' machine tools, such as planing machines, and in textile machinery. His self-acting mule was patented in 1825.

March 16, 1908. William Petrie died.—Sent at the age of nineteen to study at Frankfort-on-Main, Petrie devoted himself to electricity and magnetism, and in 1847 invented one of the first self-regulating arc lamps, which in the following year was displayed from the portico of the National Gallery. His efforts proving financially unsuccessful Petrie turned his attention to the management and equipment of chemical works.

March 17, 1806. David Dale died.—A notable Scotch industrialist, Dale began life as a Paisley weaver. He gained a fortune, however, as an importer of yarn, and in 1783, by the establishment of spinning mills at New Lanark, founded the cotton industry of Lanarkshire.

March 17, 1887. William Denny died.—The son of Peter Denny, one of the founders of the Dumbarton firm of shipbuilders and marine engineers, William Denny was one of the most scientific naval architects of his day, and at his Leven shipyard constructed the first privately-owned experimental tank, over which he placed an inscription to Froude, "The greatest of experimenters and investigators of hydrodynamics."

March 18, 1899. Sir Douglas Strutt Galton died.—A captain in the Royal Engineers, Galton did valuable work in connection with the application of iron to railways, structures, and the laying of the Atlantic cable, and was well known for his writings on sanitary science. He held various public offices, was made an honorary member of the Institution of Civil Engineers, and in 1895 served as president of the British Association.

March 19, 1888. Thomas Russell Crampton died.—An assistant to Gooch in the Great Western Railway, Crampton in 1848 set up in business for himself, and in that year constructed the locomotive "Liverpool," one of the most powerful engines of the time. It embodied many special features and was adopted as the type of locomotive for some of the French railways. Crampton also laid the first practical submarine cable from Dover to Calais, and with Fox carried out the Berlin water-works.

March 21, 1888. Ludwig August Colding died.—From the Polytechnic School at Copenhagen Colding passed into the public service and became an inspector of roads. While thus engaged, in 1843 he wrote his "Theses concerning Moving Forces," a paper which entitles him to a place among the founders of thermodynamics. He published other scientific memoirs and rose to be chief engineer of Copenhagen.

March 21, 1914. August Wöhler died.—One of the earliest and most distinguished of Prussian railway engineers and a pioneer in the testing of materials, Wöhler began his investigations on railway axles in 1852, and in 1859 established at Berlin an experimental station for the testing of iron and steel under repeated stresses.

March 22, 1831. William Symington died.—The maker of the first practical marine steam engines, Symington by his work for Patrick Miller in 1788 and for the Earl of Dundas in 1801 solved the problem of driving boats by steam, but failing to obtain support for his projects he sank into poverty and died in London a disappointed man. He is buried in St. Botolph's, Aldgate.

E. C. S.

Societies and Academies.

LONDON.

Geological Society, February 17.—Mr. R. D. Oldham, president, in the chair.—R. D. **Oldham**: The cause and character of earthquakes (Anniversary Address). The term "earthquake" is here applied only to a disturbance which can be felt, and as such, it is a form of elastic wave-motion of extreme complexity; this may be distinguished as the orchesis of the earthquake. In addition there is, in some cases, a molar, permanent displacement of the solid rock, which forms the mochleusis, which is probably the secondary result of a more deep-seated disturbance, which has been distinguished as the bathyseism. The origin of the elastic wave-motion must be a sudden disturbance not more than ten miles down, and in this outer portion of the earth's crust the only sudden disturbance conceivable is fracture. In certain cases such fracture, accompanied or not by displacement, has been recognised at the surface, and measurements of the displacements show that a state of strain must have existed before actual rupture took place, but give no indication of the rate of growth of the strain. This problem can only be attacked through the variation in the frequency of earthquakes, and only one existing record, the Italian one, is available. From this the rate of growth of strain is, at slowest, such that the breaking-point will, on the average, be reached in a year at most, and, at the quickest, may be of such rapidity as to be analogous to a separate explosion for each earthquake. Changes producing such strains are probably to be referred to the material below the crust. Researches on the change of bulk resulting from a change in the mineral aggregation of the same material indicates one means by which the effect may be brought about. The cause of the great majority of earthquakes is a rapid growth of strain, due to changes in the material underlying the outer crust of solid rock.

February 22.—Prof. A. C. Seward, president, in the chair.—C. W. **Andrews**: Description of a new Plesiosaur from the Weald Clay of Berwick (Sussex). The parts preserved are the posterior region of the skull, numerous cervical and dorsal vertebræ, the shoulder girdle, and the humeri. The bones lay mixed up, in an intensely hard matrix. The skull is very imperfect: it resembles the skull of *Plesiosaurus capensis*, Andrews, from the Uitenhage Series of South Africa. The cervical vertebræ are also very similar to those of the African species, having the central portion of the articular surfaces deeply cupped; they have also inter-vertebral discs, possibly of calcified cartilage, between successive centra. The clavicular arch in the shoulder girdle is large and well developed, being very similar to that of some Lower Liassic forms. The retention of this primitive condition in this and other Wealden Plesiosaurs may be the consequence of their comparatively sheltered life in a fluviatile or estuarine habitat. The name *Leptocleidus superstes* is suggested for the specimen.—T. **Landell-Mills**, A. Smith **Woodward**, and A. **Gilligan**: The Carboniferous rocks of the Deer-Lake district of Newfoundland. The Carboniferous rocks form a synclinal flexure with its longer axis trending north-east and south-west. Underlying these is a limestone series of undetermined age resting on highly-folded gneisses and schists of Archæan age. A thick mantle of Pleistocene deposits covers the whole region, but deeply-trenched valleys give good exposures of the Carboniferous rocks. Fishes and plant-remains occur abundantly at several horizons in the Lower Carboniferous shales, but no fossils have been found in the Upper

Carboniferous. The mineralogical constituents of the deposits are remarkably like those making up rocks of similar age in the north of England, hence it is inferred that the deposits on both sides of the Atlantic were derived from the same land-mass. The fish-remains are fragmentary; they represent three species closely related to those found in the Lower Carboniferous of Scotland. A group of ribs with the caudal fin and scattered scales belongs to a Dipnoan fish; a new species of Uronemus and some specimens of a Palæoniscid fish are also found.

Zoological Society, February 21.—Prof. E. W. MacBride, vice-president, in the chair.—Miss L. E. **Cheesman**: (1) The position and function of the siphon of the amphibious mollusc, *Ampullaria vermiformis*. (2) The habits, in captivity, of the fresh-water crab, *Cardisoma armatum*.—H. **Blegvad**: Animal communities in the southern North Sea.—C. Tate **Regan**: The Cichlid fishes of Lake Victoria.—C. F. **Sonntag**: (1) On the vagus and sympathetic nerves of the Edentata. (2) On the vagus and sympathetic nerves of *Hyrax capensis*.

Physical Society, February 24.—Dr. A. Russell, president, in the chair.—H. **Levy**: The number of radio-active transformations as determined by analysis of the observations. The expression for the nth product of a series of radio-active transformations is represented as the sum of n terms of the type $a_n e^{-\lambda nt}$. When n is known, the coefficients a_n and λ_n can be determined. A criterion for determining n, the number of transformations, by successive evaluation of a system of determinants constructed from the observations is given. The value of n is found from the order of the particular member of the system that vanishes.—C. H. **Lees**: A graphical method of treating Fresnel's formulæ for reflection in transparent media. The directions of the reflected and refracted rays having been determined by known graphical methods, a construction, based on Fresnel's formulæ, is given for finding the amplitudes of the electric vectors of these rays, in and normal to the plane of incidence.

Aristotelian Society, March 6.—Prof. J. S. Mackenzie in the chair.—S. N. **Dasgupta**: The Logic of the Vedanta. The earliest Upanisads, forming the concluding part of the Vedic literature, were completed certainly before 500 B.C. The main doctrine found in them is that self is the ultimate reality. This self is not the Ego but pure consciousness, which was regarded as supremely unchangeable. The early Buddhist philosophy sought to prove that everything was changing and that there was nothing which could be regarded as permanent. The nihilistic school of Buddhism as interpreted by Nagarjuna and Aryadeva (A.D. 100) demonstrated, by critical and dialectical reasoning of the type which Mr. Bradley has used, that our ordinary conceptions of experience were absolutely relative and were therefore indefinite and indefinable. The idealistic Buddhists accepted this position and held that all worldly experience is due to mental construction. The Vedanta, as explained by Sankara, and as interpreted by Sriharsa and Madhusudana Sarasvati and others, held that pure consciousness, as revealed in immediate experience and as distinct from its particular form and content, was self-contained and absolutely real. Particular forms are relative and mutually interdependent. They are definable either as being or as non-being for they participate in the nature of both. They are the modifications of a separate logical category called the indefinite and have the same sort of logical status as illusions. They appear as existent by virtue of their relation with pure consciousness which is absolutely unchangeable and self-contained and immediate. Everything which has any form or content is thus a joint manifestation of the absolutely real, *i.e.* the consciousness, and the category of the indefinite. The nature of all that is relative is that it has being in some sense and it has no being in another, and it cannot therefore be regarded either as positive or negative. This necessitates the acceptance of the indefinite as a separate logical category which explains the logical status of all that is relative.

Paris.

Academy of Sciences, February 20.—M. Emile Bertin in the chair.—E. **Borel**: Functions of a real variable capable of differentiation without limit.—H. **Douvillé**: The Nummulitic to the south of the Pyrenees.—G. **Gouy**: The tensions and pressures of Maxwell in magnets and dielectrics. Maxwell has given two expressions involving the field (H) and the induction (B), one for magnets and a second for dielectrics. Only the first of these, a tension of $\left(\frac{1}{4\pi}\right)$BH along the lines of force and a pressure p in all directions of $\left(\frac{1}{8\pi}H^2\right)$, appears to give exact results in all cases.—G. **Julia**: Functional equations and conformable representation.—J. **Rémoundos**: The coincidence of lines and the plane elastic curve.—R. **Lagrange**: Some applications of the absolute differential calculus.—B. **Gambier**: Point correspondence between two surfaces with exchange of conjugated into orthogonal systems and *vice versa*.—M. **Frontard**: Cycloids of sliding of soils.—J. **Petitpas**: The work expended in the mechanical working of wood.—P. **Bourgoin**: The velocity of combustion of colloidal powders.—A. de La Baume **Pluvinel**: A *coudée* telescope designed for the application of the method of equal heights.—M. **Baudouin**: The prehistoric material representation of the Pleiades with ten stars in a rock basin in Epesses (Vendée). This prehistoric engraving on a stone basin is unique in that ten instead of the usual seven stars are represented.—G. **Perrier**: The differences of altitude of the stations of the meridian arc of the Equator. Fifty-four of the stations on this arc, now being measured, are at heights between 3500 and 4500 metres, whilst towards the south the triangles fall suddenly to the sea-level. The reduction of the observations is discussed and it is shown that a term commonly neglected in geodesic operations must in these reductions be taken into account.—MM. **Courtines** and **Villey**: Barovariometers with capillary flow. The apparatus consists of a glass bulb, thermally isolated by a vacuum, communicating with the outside air by a capillary tube and furnished with a sensitive manometer indicating variations in the external pressure. The conditions under which the instrument can be made to furnish accurate figures are worked out.—Mlle. P. **Collet**: Thin layers formed by mixtures of glycerides.—H. **Chaumat**: The measurement of power in alternating currents in some abnormal cases.—M. **Galibourg**: The utilisation of the thermo-electric force of contact for the identification of certain steels. Diagrams of the apparatus used are given and some figures obtained for carbon, silicon, nickel, and chrome tungsten steels. Taken in conjunction with the Brinell test, the determination of the thermo-electromotive force at 120° C., under the conditions indicated, suffices to determine the nature of the steel without an analysis.—M. **Curie**: The action of the red and infra-red rays on phosphorescent sulphides. The author puts forward the hypothesis that the action of the extinguishing rays consists in making the medium

conduct by detachment of electrons from the atoms of sulphur.—G. **Mouret**: The prolongation of the fracture of Argentat (Corrèze) in the region of Dorat (Upper Vienne and Vienne).—L. **Dussault**: The Tam Dao and the region of the lower river Claire (Tonkin).—C. **Gorceix**: The formation of the "Gouf de Cap-Breton." A close study of the profile of this cavity shows that it cannot be regarded as an estuary or valley. The best explanation of the observed facts appears to be the assumption of a band of gypsum-salt formation; the gypsum and the salt have been dissolved by water and the associated clay washed out.—J. **Fromaget**: The geology of the environs of A Mi Tchéoü (Eastern Yunnan).—M. **Gignoux**: The presence of the Tortonian at Valence (Spain).—E. **Wertheimer**: The entero-hepatic circulation of the bile acids. A description of an experiment confirming the views of Stadelmann on the passage of glycocholic acid in bile of the dog. The elimination of the bile acids takes place exclusively through the intermediary of the portal vein.—F. **Maignon**: Researches on the physiological and therapeutic properties of the diastases of the tissues. The existence of synthesising diastases. An account of experiments on the injection and ingestion of diastases extracted from various organs (thyroid, suprarenal capsules, ovary, pancreas, etc.). The action of these diastases is specific, in the sense that those extracted from the liver exert hepatic functions only, those from the thyroid affect the thyroid secretion, etc. These diastases have no action when administered to healthy subjects whose organs are working normally.—R. **Jeannel**: The geographical dispersion of *Silphidae Catopinae* during the Tertiary period.—R. **Noël**: The phenomena of condensation of fatty bodies on the surface of mitachondria.—R. **Argaud**: Some functions of the tumoral megacaryocyte and especially its vasoformative function.—A. **Goris** and A. **Liot**: New observations on the culture of the pyocyanic bacillus on definite artificial media. The amides could not be used for the culture of this bacillus; amino acids could be used, but growth did not take place so readily as with ammoniacal salts of dibasic acids.—L. **Cavel**: The method of purification by means of activated sludge and its application to the separative system.—J. **Glover**: Electrical auscultation of respiration at the commencement of tuberculosis. A new method of auscultation based on the use of amplifying microtelephonic stethoscopes.—E. **Sergent** and A. **Donatien**: The stomox as a propagator of trypanosomiasis in dromedaries.

Official Publications Received.

Bulletin of the National Research Council, vol. 3, Part I., No. 16, December: Research Laboratories in Industrial Establishments of the United States. By Alfred D. Flinn. Revised and enlarged by Ruth Cobb. Pp. 135. (Washington: National Academy of Sciences.) 2 dollars.

Smithsonian Institution: United States National Museum. Bulletin 113: Life Histories of North American Gulls and Terns: Order Longipennes. By Arthur C. Bent. Pp. x+345+93 plates. Bulletin 114: A Revision of the King Snakes: Genus Lampropeltis. By Frank N. Blanchard. Pp. vi+260. (Washington: Government Printing Office.)

The Carnegie United Kingdom Trust. Eighth Annual Report (for the Year ending 31st December 1921) submitted by the Executive Committee to the Trustees on Friday, 3rd March 1922. Pp. ii+66. (Edinburgh.)

Department of Commerce. Technologic Papers of the Bureau of Standards. No. 204: Cutting Fluids. By Eugene C. Bingham. Pp. 35-76. (Washington: Bureau of Standards.) 15 cents.

Department of Commerce. Scientific Papers of the Bureau of Standards. No. 422: Studies in Color Sensitive Photographic Plates and Methods of Sensitizing by Bathing. By Francis M. Walters, Jr., and Raymond Davis. Pp. 353-375. 15 cents. No. 424: Mathematical Theory of Induced Voltage in the High-Tension Magnets. By Francis B. Silsbee. Pp. 407-470. 15 cents. No. 425: Characteristic Soft X-rays from Arcs in Gases and Vapours. By F. L. Mohler and Paul D. Foote. Pp. 471-496. 10 cents. No. 426: Thermal Expansion of Nickel, Monel Metal, Stellite, Stainless Steel, and Aluminium. By Wilmer H. Souder and Peter Hidnert. Pp. 497-519. 10 cents. No. 427: Some Effects of the Distributed Capacity between Inductance Coils and the Ground. By Gregory Breit. Pp. 521-527. 5 cents. (Washington: Bureau of Standards.)

Ministry of Public Works, Egypt. Report on the Work of the Physical Department for the Year ending March 31, 1921. By Dr. H. E. Hurst. Pp. ii+22. (Cairo: Government Publications Office.) P.T. 5.

Ministry of Finance, Egypt. Survey of Egypt: Geological Survey. Palæontological Series, No. 5: Catalogue des Invertébrés fossiles de l'Égypte représentés dans les Collections du Musée de Géolgie au Caire. Par R. Fourtau. Terrains Crétacés—3me Partie: Échinodermes (Supplément). Pp. viii+101+v+11 plates. (Cairo: Government Publications Office.) P.T. 50.

Synoptic Series of Objects in the United States National Museum Illustrating the History of Inventions. By Walter Hough. (No. 2404, From the Proceedings of the U.S. National Museum, Vol. 60, Art. 9.) Pp. 47+56 plates. (Washington: Government Printing Office.)

Fifty-ninth Annual Report of the Secretary of the State Board of Agriculture of the State of Michigan and Thirty-third Annual Report of the Experiment Station from July 1, 1919, to June 30, 1920. Pp. 700. (Lansing, Mich.)

Department of the Interior: United States Geological Survey. Bulletin 679: The Microscopic Determination of the Nonopaque Minerals. By Esper S. Larsen. Pp. 294. (Washington: Government Printing Office.)

Report of the Secretary of the Smithsonian Institution for the Year ending June 30, 1921. (Publication 2659.) Pp. 119. (Washington: Government Printing Office.)

University of Wisconsin Studies in Science. No. 1: The Fishes of Lake Valencia, Venezuela. By Prof. A. S. Pearse. Pp. 51. 50 cents. No. 2: Papers on Bacteriology and Allied Subjects. By Former Students of Harry L. Russell. Pp. 199. 1 dollar. No. 3: The Distribution and Food of the Fishes of Three Wisconsin Lakes in Summer. By Prof. A. S. Pearse. Pp. 61. 50 cents. (Madison: University of Wisconsin.)

Proceedings of the First Pan-Pacific Scientific Conference under the Auspices of the Pan-Pacific Union, Honolulu, Hawaii, August 2 to 20, 1920. Part 1. Pp. ix+308. Part 2. Pp. iii+309-636. Part 3. Pp. iii+637-950. (Bernice P. Bishop Museum Special Publication, No. 7, parts 1, 2, and 3.) (Honolulu: Honolulu Star-Bulletin, Ltd.)

Ministère de l'Agriculture. Direction générale des Eaux et Forêts. (2me Partie.) Service des Grandes Forces Hydrauliques (Région du Sud-Ouest). Résultats obtenus pour le bassin de l'Adour, pendant les années 1917 et 1918. Tome VII, Fascicule B. Pp. 48+charts 2-65. Résultats obtenus pour le bassin de l'Adour. Tome Ibis, Fascicule A. Pp. iv+charts 2-67. (Paris: Ministère de l'Agriculture.)

Diary of Societies.

FRIDAY, MARCH 17.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.

INSTITUTE OF TRANSPORT (at Royal Society of Arts), at 5.—F. Pick: The Operation of an Omnibus Company, with reference to Capacity and Cost under Given Conditions.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—P. C. Dewhurst: British and American Locomotive Design and Practice.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—C. C. H. Wade: The Electron Theory.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—G. H. Ayres: Power Factor Improvement.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. M. Legge and others: Discussion on the Pathological Changes produced in Subjects rendered Unconscious by Electric Shock, and the Treatment.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. A. P. Laurie: The Pigments and Mediums of the Old Masters.

SATURDAY, MARCH 18.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (3).

PHYSIOLOGICAL SOCIETY (at University College).

MONDAY, MARCH 20.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—Capt. H. Whittaker: Hydro-electric Course at the University of Grenoble.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. D. Searles-Wood: The Building Timbers of the Empire.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.1), at 8.—Prof. R. F. A. Hoernlé: Some Byways of the Theory of Knowledge.

ROYAL SOCIETY OF ARTS, at 8.—L. G. Radcliffe: The Constituents of Essential Oils (Cantor Lectures) (1).

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—H. Temperley: The Geography of the Treaty of Rapallo.

TUESDAY, MARCH 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire. Series I. Racial Problems in Asia and Australasia (5).

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. Feiling: The Interpretation of Symptoms in Disease of the Central Nervous System (Goulstonian Lectures) (1).

ROYAL STATISTICAL SOCIETY, at 5.15.—J. Y. Hart: Sickness Data of Public Elementary School Teachers in London 1904–1919.
MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—Sir William Bragg: Recent X-ray work on the Crystal Structure of Organic Substances.
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—G. Blaine: Notes on the Zebras and some Antelopes of Angola.—R. I. Pocock: The External Characters of some Histricomorph Rodents.—H. R. Hogg: Some Spiders from South Annam.
INSTITUTION OF CIVIL ENGINEERS, at 6.—W. Willox: All-Electric Automatic Power Signalling on the Metropolitan Railway.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—S. Bridgen: Landscape from the Practical Side.
RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Sir Oliver Lodge: Magnetism—and the Ether (Fifth Silvanus Thompson Memorial Lecture).

WEDNESDAY, MARCH 22.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Sir Charles J. Holmes Lionardo da Vinci as a Geologist.
ROYAL SOCIETY OF ARTS, at 8.—Prof. A. P. Laurie: The late Mr. Holman Hunt's Experiments on the Permanency of Artists' Oil Colours.

THURSDAY, MARCH 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. P. Chalmers Mitchell: The Cinema as a Zoological Method (2).
ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Sir Richard Glazebrook: The Specific Heats of Air, Steam, and Carbon Dioxide.—Lord Rayleigh: A Photographic Spectrum of the Aurora of May 13-15, 1921, and Laboratory Studies in connection with it.—F. A. Freeth: The System: $Na_2-CO_2-NaCl-H_2O$.—M. A. Catalán: Series and other Regularities in the Spectrum of Manganese.—D. W. Dye: Calculation of a Primary Standard of Mutual Inductance of the Campbell Type and Comparison of it with the similar N.P.L. Standard.—P. E. Shaw and N. Davy: The Effect of Temperature on Gravitative Attraction.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. Feiling: The Interpretation of Symptoms in Disease of the Central Nervous System (2).
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—F. Whelen: The League at Work (League of Nations Union).
CONCRETE INSTITUTE, at 7.30.—S. F. Staples: Floating Docks.

FRIDAY, MARCH 24.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Prof. H. E. Armstrong: The Indigo Situation in India.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.
INSTITUTION OF PRODUCTION ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—E. Fairbrother: Inspection Methods.
JUNIOR INSTITUTION OF ENGINEERS, at 8.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. F. G. Donnan: Auxiliary International Languages.

SATURDAY, MARCH 25.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (4).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

FRIDAY, MARCH 17.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (9).
KING'S COLLEGE, at 5.—Prof. R. Robinson: Orientation and Conjugation in Organic Chemistry from the Standpoint of the Theories of Partial Valency and of Latent Polarity of Atoms (3).
TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. C. Miller: The New Psychology and its Bearing on Education (8).
BIRKBECK COLLEGE, at 8.—F. Hodges: Trade Unionism. (Meeting arranged by the London Branch of the National Union of Scientific Workers.)

SATURDAY, MARCH 18.

THE POLYTECHNIC (Regent Street, W.1), at 10.30 A.M.—P. A. Best: The Romance of Commerce.
HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: The Natural History of Elephants.

MONDAY, MARCH 20.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. H. Roger: Les fonctions du Poumon.

TUESDAY, MARCH 21.

KING'S COLLEGE, at 5.30.—F. H. Rolt: Accurate Measurements in Mechanical Engineering: The Use and Testing of Gauges (5).
UNIVERSITY COLLEGE, at 5.30.—Col. W. M. St. G. Kirke: Imperial Defence as affected by the War (2).

WEDNESDAY, MARCH 22.

SCHOOL OF ORIENTAL STUDIES, at 12.—Miss Alice Werner: Bantu Mythology and Folklore (5).
EAST LONDON COLLEGE, at 4.—Prof. F. E. Fritsch: Certain Aspects of Freshwater Algal Biology (6).
SCHOOL OF ORIENTAL STUDIES, at 5.—M. de Z. Wickremasinghe: Tea and Rubber Industries in Ceylon.
KING'S COLLEGE, at 5.15.—Prof. N. Bohr: The Quantum Theory of Radiation and the Constitution of the Atom (3).
HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (9).
UNIVERSITY COLLEGE, at 8.—The Current Work of the Biometric and Eugenics Laboratories (6). Dr. M. Greenwood: Occupational Mortality.

THURSDAY, MARCH 23.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. A. Chauffard: Syndrome Humoral de la Goutte.
SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. L. D. Barnett: The Hindu Culture of India (4).
KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (10).
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. E. Stilgoe: Water (1): Its Storage and Filtration (Chadwick Lecture).

FRIDAY, MARCH 24.

METEOROLOGICAL OFFICE, (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (10).
KING'S COLLEGE, at 5.30.—Dr. G. Cook: Some Recent Advances in our Knowledge of the Strength of Materials.

SATURDAY, MARCH 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: Science and the Food we eat.

CONTENTS.

THURSDAY, MARCH 23, 1922.

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The Universities and Colonial Scientific Services.[1]

THE unfortunate shortage of trained men at the end of the war, at a time when many of the Colonies were especially anxious for expert help in reorganisation and further development, led to various suggestions for the increase in the supply. Lord Milner, as Colonial Secretary, accordingly appointed a Committee in 1920 to investigate how the universities could best help in training men for the scientific services abroad and in securing the research necessary for the protection of the inhabitants of the Colonies against disease and for the development of their veterinary, agricultural, and mineral resources. The Committee consisted of Lord Chalmers as chairman, Sir Henry Birchenough, Sir John Rose Bradford, Sir Walter M. Fletcher, Prof. E. B. Poulton, Sir David Prain, Sir H. J. Read, Sir Stewart Stockman, and Sir Aubrey Strahan. The Committee has now issued its Report. It concludes that the universities can help mainly in two ways—in the fuller training of students and in the building up of a corps of advanced workers who would be available for the solution of especially complex problems.

The Committee's conclusion that the universities must impart to the students who desire to enter the Colonial services more than "book knowledge" will be universally approved, but the suggestion that some universities still give scientific courses without laboratory and practical instruction will be read with surprise. The Committee further insists that the men required must have "a training in the methods of research, and this involves post-graduate study." It concludes, therefore, that the universities can assist most usefully and directly by encouraging post-graduate study, and for this purpose urges that an increase of research fellowships and studentships would be of primary importance.

The Report implies that appointments in the scientific departments of the Colonies should be restricted to men who have been through post-graduate courses, but this limitation would be attended by serious drawbacks, especially in tropical colonies. The men would begin their service later and would retire when older or with a smaller pension, and the men who have taken the extra years of post-graduate work would be lower in seniority than those who had joined the service at the end of the ordinary university course. The better-trained men would thereby be debarred, as a rule, from securing the head appointments, with probably much consequent jealousy and friction. The attempt to correct this evil by dividing the staff of a small department into two grades and restricting the upper grade to men who have had post-graduate training would lead to even greater difficulties.

The Committee's conclusion implies that the courses for university degrees do not include training in the methods of research, although that training is the essential of university education. Research training should be improved, not by lengthening the time at the university, but by earlier specialisation in the case of students requiring a professional scientific qualification. The universities provide for two sets of students, whose requirements are different. They have to teach the pedagogic methods and general principles, by knowledge of which teachers may widen the mental outlook of their pupils and inculcate habits of scientific thought. They must also teach students who intend to adopt science as a profession, other than in secondary education and medicine, how to use the methods by which the various sciences have achieved their present position and may be further advanced. Now that a four years' course for the honours B.Sc. is becoming the rule, the university science courses should provide training in the methods of research for at least two of the four years for students who require it; and men so trained should be able to give useful service in the ordinary research work required in most colonial departments. The desired increase in the output of men trained for research would be even better secured by encouraging the universities to provide further teaching in research methods in the course for the B.Sc. without adopting the principle that such training "involves post-graduate study."

The second problem which the Report considers is the provision of experts to solve the specially intricate problems that would be met with from time to time. The university staffs might be expected to help in such

[1] Report of a Committee on Research in the Colonies. (Cmd. 1472.) 12 pp. 8vo. (His Majesty's Stationery Office, 1921.) 2*d*.

work, men being seconded for service as required. The Committee, however, expects such problems to be so numerous that the universities could give adequate help only if their scientific staffs were greatly enlarged. To secure this increase the Report adopts Lord Milner's suggestion that research departments should be established at those universities to which the subject would appeal by local interests or environment. Lord Milner has promised that if the universities would endeavour to collect funds from local industries for such departments, the Colonial Office would support the appeals by testifying that the establishment of new chairs and the enlargement of the professorial staffs in the departments of science throughout the universities would be a great and permanent service to the Empire.

Sir Walter Fletcher, in a reservation appended to the Report, regrets that its proposals regarding appeals for such endowments are so indefinite. He remarks that it leaves untouched the practical questions as to "Who will make the appeal? What appeal? By what mechanism or in what modes? And on what occasions?" He says that no steady cultivation of university resources for the ends proposed can be effected without a general scientific staff, and recommends a special advisory committee in each of the departments of science concerned. Sir Herbert Read replies to this criticism, in a covering letter annexed to the Report, that the Colonial Office has already the help of adequate advisory committees, and that in some subjects there are, indeed, too many. Thus, dealing with tropical medicine there are the Tropical Diseases Bureau, the Tropical Diseases Research Fund Committee, the Advising Medical and Sanitary Committee for Tropical Africa, and the Schools of Tropical Medicine in London and Liverpool. Sir Herbert Read remarks that in this case the machinery should be simplified and not enlarged; but, despite this experience, the establishment of scattered research institutes is the system which the Committee recommends. Laboratories for special researches attached to university departments are subject to the risk of lack of continuity between the work of one professor and that of his successor. This drawback may be reduced by the establishment and endowment of research chairs to superintend such laboratories; but, even if the funds could be obtained, such chairs might soon outlive their usefulness owing to changed industrial conditions.

The establishment of these independent research institutes might prove an extravagant method of conducting much of the ordinary research necessary for colonial development. A central institution, which could call on the university staffs to help with special problems, might be a far more economical method of organising this work. There is already such an institution—the Imperial Institute. The Report does not mention it, though reference is made to its work, for a letter by Lord Milner which is printed with the Report, illustrates the great economic value of scientific investigation by the discovery of the Udi coalfields in Nigeria, which was due to a survey organised by the Imperial Institute under a man whom it enlisted. The Imperial Institute is under the management of the Colonial Office, and its extensive laboratories, staff, and resources should be available for the investigation of problems connected with economic biology, geology, and mineralogy, in any part of the Empire which has not adequate scientific departments of its own. As the Committee was appointed to consider the relations of the universities to research, the Imperial Institute may have seemed outside its province. Its scheme is, however, attended by the danger of overlap of the kind which, as Sir Herbert Read remarks, has already developed not only between different independent departments, but also between all the proposed research institutes and the Imperial Institute, which was founded expressly to investigate the economic resources of the British Empire overseas.

A Monograph on Wheat.

The Wheat Plant: A Monograph. By Prof. J. Percival. Pp. x+463. (London: Duckworth and Co., 1921.) 63*s*. net.

PROF. PERCIVAL'S monograph fills one of the many great gaps in English agricultural literature by providing, for the first time in our language, a comprehensive account of the wheat plant, the most important of the cereal crops. Some idea of the magnitude of the work involved in the production of this book is derived from a statement in the preface that it is based on the study of what is "probably the most representative collection in existence," since it "includes all the races of wheats, numbering nearly 2000 forms derived from almost all wheat-growing regions of the world," whilst a brief glance at any section of the book is sufficient to convince the reader, especially perhaps the reader familiar with the crop, that this study has been peculiarly exhaustive.

Part 1 is devoted to the results of investigations on the morphology, anatomy, development, and growth of the wheat plant. When the importance of the crop is taken into consideration the existing literature on these subjects is singularly scanty, and the detailed accounts, covering some 140 pages, will save trouble to many future investigators. Further information on the cytology of the chief races of wheat and on the

details of fertilisation is still required; but, apart from this, we now possess sufficient knowledge of the minute structure and of the development of the wheat plant for most purposes.

The greater portion of Part 2 consists of a series of chapters dealing with the classification of the numerous "forms," many of which the author has had under observation for as many as twenty years. At the outset two wild species, *Triticum aegilopoides*, Bal., and *T. dicoccoides*, Körn., are recognised, together with eleven "races" or cultivated species. Eight of the latter, the small Spelt, Emmer, Macaroni, Polish, Rivet wheat, Bread wheat, Club wheat, and large Spelt, are well-known races; whilst three, *T. orientale*, Khorasan wheat, *T. pyramidale*, Egyptian cone wheat, and *T. sphaerococcum*, Indian dwarf wheat, are new creations. The first of these consists of a couple of Emmer-like varieties, differing only in awn-colour, which are characterised by the possession of long glumes and grain. The second consists of a group of five Egyptian wheats coming close to the Rivet wheats in most of their characteristics, and in leaf colour, shortness of straw, and ear shape strongly reminiscent of segregates from crosses between *T. turgidum* and *T. vulgare*. The third is an equally small group of round-grained forms coming near *T. compactum*. The further sub-division of these races into "varieties" follows the well-known system in Körnicke and Werner's "Handbuch des Getreidesbau."

But this system is not slavishly adhered to, and here and there noteworthy departures are made from it. For instance, several forms placed by Körnicke in *T. durum* are rightly transferred to the Emmer group, *T. dicoccum*. Persian Black, too—a form which has puzzled more than one systematist—is also placed in this group, to the satisfaction of those interested in the genetics of this important mildew-resisting wheat.

In the smaller groups the sub-division of the varieties into forms is a comparatively simple matter, but difficulties occur in the large races, such as *T. vulgare*. If, by way of example, one takes the first of the beardless varieties of the bread wheats, *T. v. albidum*, one finds detailed descriptions, under either a name or a number, of a dozen forms from various parts of the world, supplemented by excellently reproduced photographs of the more distinct types. But the forms themselves are capable of further sub-division. Under the description of Wilhelmina, for instance, is the statement: "Similar to this is Willem I. from Holland, Victor, Stand Up, Essex hybrid. . . ." Some of these are almost unquestionably synonymous, whilst some are distinct wheats, and a classification failing to differentiate these will disappoint many who grow wheat.

But, whatever the needs of the wheat-grower for a still finer differentiation of forms, one feels that the day for these elaborate descriptions is passing and that it is unlikely that many attempts will be made in the future to bring together and catalogue the world's numerous wheats. Even now, when the subject of wheat-breeding is in its childhood, the geneticist foresees the possibility of an accession of new forms which would reduce Prof. Percival's collection to the dimensions of a dwarf. Such a feature as the winged glume figure in Plate 179 is known to him only in one form. But it is inherited as a unit character, and though scores of forms with similar glumes are in existence at the Plant-Breeding Institute at Cambridge, many more could easily be raised. Much the same is true of that still rarer feature, the purple colour of the grain, seen in *T. d. arraseita*, which has in the hands of the hybridist given rise to a series of purple-grained Macaroni and Polish wheats, in addition to other forms of Emmers. To cope with such a "flora," the systematist of the future will probably have recourse to brief formulæ expressing the genetic constitution of each form—a system which would have many of the merits of that used in the classification of bacteria.

The systematic portion of the monograph is followed by a chapter of considerable interest on the origin and relationship of the races of wheat. Evidence from various sources—archæological, ecological, pathological, genetical, etc.—is skilfully marshalled to show their probable lines of development. The story is too long to discuss within the limits of a review, but Prof. Percival's conclusions on the origin of the bread wheats (*T. vulgare*) are too interesting to pass over. At present, as is well known, no wild species even suggestive of this group has been found. A study of the morphology of the wild and cultivated wheats has led the author to the conclusion that "there is not nor has there ever been a prototype of the bread wheats." And further: "The characters of *T. vulgare* and its allies appear . . . to be those of a vast hybrid race, initiated long ago by the crossing of wheats of the Emmer series with species of Ægilops." It so happens that many crosses have been made between the reputed Ægilops parents, *Æ. ovata* and *Æ. cylindrica*, and forms from practically all the races of wheats; but such crosses yield, at the most, sterile hybrids. The significance of this fact is recognised, but disposed of by the assumption that natural hybrids between the wild Ægilops and the Emmer prototype are more fertile under their native climatic conditions than in Central or Western Europe.

A chapter on yield follows a useful summary of most of the more important literature dealing with the hybridisation and improvement of wheat. In this

the effects of soil, cultivation and manuring, seed rate, variety, time and methods of sowing, and size of grain are considered.

One can but regret that it is not followed by a chapter on quality, in which the effects of these factors on the milling and baking properties of the bread wheats is brought under review. Such a chapter would be peculiarly welcome to both wheat-breeders and millers, even if it did no more than summarise the scattered literature on the subject. It would, moreover, go some way to justify the statement on the wrapper of the book that it is "essential to . . . plant-breeders and millers." Prof. Percival will lay workers on both these subjects under a still greater obligation if such an addition is made when a new edition of this useful volume is called for. R. H. B.

The Subjectivity of Psychology.

The Psychology of Everyday Life. By Dr. James Drever. Pp. ix+164. (London: Methuen and Co., Ltd., 1921.) 6*s.* net.

THE present generation is witnessing a sustained and persistent effort to raise psychology to the status of a science. Hitherto it has been a part of philosophy, and it is felt by psychologists that success depends wholly on their being able to detach it. There is something curiously instructive in the fact that the task is avowedly difficult. It is curious because the data of psychology are more immediate than any other data of science, and for that reason alone we should expect them to be the most easily known and the most susceptible to treatment. But the instructive thing is that this very intimacy of our relationship with the data militates against scientific treatment. All the trouble in regard to the matter arises from the fact that the objects of a science of psychology are more difficult to abstract from the subject of experience, more difficult to reify or set up with an independent status of their own, than are the objects of any recognised science, mathematical, physical, or biological.

This is obvious at once if we compare psychology with its nearest neighbour in the hierarchy, physiology. We have no trouble in presenting the functions of anatomical organs, and the processes of secretion, circulation, innervation, and the like, as objective. They are capable of mechanistic interpretation in complete detachment from anything which depends on the experience of the subject, although we are ready to acknowledge that without such experience the apparent purpose of the mechanism would be wanting. But when we try in the same way to present instincts, impulses, emotions, feelings, memory, wishes, trains of reasoning, we seem to be in a peculiar difficulty, for it is impossible to avoid not merely subjectivity, but a certain vexatious personal and individual subjectivity. Yet there is no obvious reason for this, and the more we reflect the more we are driven to recognise that while we know as matter of fact that it is so, we do not know and are unable to imagine the reason why it should be so.

The difficulty goes back at least to Berkeley. It is quite easy to imagine perfect cubes and circles and other geometrical figures existing entirely independently of the mind which knows them and to found a science on the assumption that they may or do so exist. The same is true in some measure of all the physical and biological sciences. But a wish, a pain, a thought, absolutely refuse to be detached, and will not let us imagine an abstract existence for them independently of the subject. Now Berkeley's contention was that every object of knowledge is in the same case, and therefore the physical sciences have no advantage over psychology. This, however, gives no satisfaction to the modern psychologist, for whatever be the truth of Berkeley's doctrine he knows that physics and biology possess at least a *practical* advantage which is lacking to psychology.

The little manual by Dr. Drever, which is the occasion of this reflection, is an excellent classification and general survey of the nature of the entities with which the modern science of psychology is attempting to deal. What seems to qualify the author for his task is his thorough knowledge of the older and philosophical treatment of the subject, in particular with its treatment in books like Descartes's "Les Passions de l'Ame" and Malebranche's "Recherche de la Vérité." Dr. Drever is in thorough sympathy with the scientific end, and is working towards it, yet with full consciousness and complete understanding of its origin in philosophy.

H. WILDON CARR.

The Study of Earthquakes.

A Manual of Seismology. By Dr. Charles Davison. (Cambridge Geological Series.) Pp. xii + 256. (Cambridge: At the University Press, 1921.) 21*s.* net.

TIME was when the meaning of seismology was clear and unmistakable; it was the study of earthquakes, and by earthquakes was meant the disturbance which could be felt, and, when severe, caused alarm and damage. It was known that there was a central area where the earthquake was most severe, fringed by zones of decreasing violence, until a region was reached where it was insensible to the unaided senses, though still recognisable by suitable

instruments, and when, towards the end of last century, it was found that, at distances far away from the region affected by the sensible shock, disturbances which were clearly connected with great earthquakes could be detected by suitable instruments, it was natural to suppose that the origin was the same for both. Only of recent years has it been recognised that the earthquake proper, caused directly by fracturing of the surface rocks, is but a secondary effect of a more deep-seated disturbance, or bathyseism, which, and not the earthquake proper, is presumably the origin of the disturbance represented in the preliminary tremors of the distant record.

Meanwhile, seismology has developed on two distinct lines, and in reality into two distinct sciences, differing in method, means, and requirements. On one hand, we have the newer seismology of the long-distance record, in which personal observation counts for nothing; some mechanical ingenuity is required for the design of efficient instruments, some care in the maintenance of them and their records, but after that, the discussion and interpretation are purely a matter of the higher mathematics. On the other hand, we have the older seismology, in which there is still much work to be done, even with no further mathematical equipment than an intelligent schoolboy may carry away from a modern public school, but in which the collection of data is entirely dependent on personal observation, and the coincidence of occasion and a competent observer.

With such a difference of scope and methods, it is scarcely possible for one individual to become a master of both branches, and this is illustrated by the existence of two recent text-books, both nominally of seismology; first we have the "Modern Seismology" of the late Dr. G. W. Walker, which appeared some years ago and is an admirable introduction to the newer development of the subject, but scarcely refers, and only incidentally, to the earthquake proper; then we have this book, by Dr. C. Davison, which is called a manual of seismology and devotes only a part of one chapter to the subject of Dr. Walker's book. The difference accounts for, and is indicated by, the fact that one appeared as a Monograph on Physics, the other as part of the Cambridge Geological Series.

The object, as well as the scope, of Dr. Davison's work accounts sufficiently for the fact that he devotes only part of a chapter to the newer seismology, and the treatment is adequate, in so far as it gives that amount of information which a student of the older seismology cannot afford to ignore. As a manual of that older seismology the book fills a much-felt want, for we had no satisfactory introduction to the study of the earthquake proper. Well arranged and clearly expressed, the only adverse criticism which can be made is that the ground is possibly too fully covered, and that some matters which might have been omitted from an introductory text-book have necessarily received too brief a treatment; but this fault—if such it be—is counteracted by the references to other works in which the subject is more fully dealt with. These references to previous literature add very greatly to the value of the work; not large in number, they are very judiciously selected, form a satisfactory basis for advanced study in all branches of the subject, and, without exception, are such that no one wishing for a mastery of the subject could afford to leave them unstudied.

R. D. O.

Chemical and Physical Constants.

Handbook of Chemistry and Physics. A Ready-Reference Pocket Book of Chemical and Physical Data. By Prof. C. D. Hodgman, assisted by Prof. M. F. Coolbaugh and Cornelius E. Senseman. Eighth edition. Pp. 711. (Cleveland, Ohio: Chemical Rubber Company, 1920.) 3 dollars.

THIS compact little volume contains a vast array of chemical and physical constants. Since the first publication in 1914 it has passed through eight editions in the United States—a sufficient proof of its utility as "a comparatively comprehensive reference book for use in the laboratory or classroom."

The tables on the properties of inorganic and organic compounds are very complete, and chemists will appreciate particularly the tabular information on the solubility of inorganic salts in water. The data on the "Dehydration of Metallic Sulphates" and the "Decomposition of Anhydrous Metallic Sulphates" are distinctly novel features. In the qualitative analysis scheme it is somewhat difficult to follow out the behaviour of chromium. A very complete table is given of heats of formation and solution, but it is to be regretted that no indication is given as to the sources from which the data have been compiled.

The section devoted to physics is fairly complete, and one notes with pleasure that the table for the reduction of psychrometric observations refers to the ventilated type of wet and dry bulb thermometer only. At the end of the volume eight pages are devoted to problems, the utility of wh h in a book of data is doubtful.

The book has some blemishes, for the most trustworthy data have not always been chosen. To take one example only, in the table of "Fixed Points for High Temperatures" the melting point of nickel is given as 1427° and that of platinum as 1775°. Ten years ago the Carnegie Institution published a memoir on High Temperature Gas Thermometry, and the values

there given (1452° and 1755°) have since been almost universally accepted. Also, in view of the thorough work of Prof. Callendar on the specific heat of water, it is somewhat surprising to find that the values given are "the mean of various determinations, including Calendar and Blonsfield, 1912"; one frequently observes that the names of observers are misspelt as in this quotation.

It is hoped that before the next edition is issued the various sections will be submitted to expert scrutiny, for the value of the book would be greatly enhanced if the user could feel sure that the most trustworthy data are quoted. E. Griffiths.

Our Bookshelf.

Illustrations of the Flowering Plants and Ferns of the Falkland Islands. By Mrs. E. F. Vallentin. With descriptions by Mrs. E. M. Cotton. Pp. xii+64 plates+text+ii. (London: L. Reeve and Co., Ltd., 1921.) 84*s.* net.

Since the publication of Sir J. D. Hooker's "Flora Antarctica" much progress has been made in the study of the Falkland flora and from a taxonomic standpoint it may now be said to be well known. Nevertheless, a well-illustrated compact flora has been a desideratum and it is thus additionally unfortunate that owing to a serious breakdown in health the completion of Mrs. Vallentin's work has been indefinitely postponed. The volume now under notice contains 64 plates illustrating in colour, and with excellent dissections, many of the most characteristic Falkland plants. Each plate is accompanied by a short description of the family, genus and species. It seems a pity that with the space available fuller descriptions and more detailed ecological notes have not been provided. The repetition of the description of the family appears to be unnecessary; thus the same diagnosis of the Compositæ is repeated eleven times.

The work as a whole illustrates many of the essential features of the Falkland Islands flora. The predominance of dwarf herbaceous and subshrubby perennials, especially characteristic of steppe and heath formations, is emphasised both by the plants chosen for illustration and by the small number of therophytes and the absence of phanerophytes, except for a few nanophanerophytes.

We have no doubt that this work will prove most useful to inhabitants of the Falkland Islands who take an interest in the natural history of their country by enabling them to identify easily many of the common plants around them, and that it will also be used in a more general manner by workers in systematic and geographical botany in other countries.

W. B. Turrill.

The Microscope: Its Design, Construction and Applications. A Symposium and General Discussion by many Authorities. Edited by F. S. Spiers. Pp. v+260 +plates. (London: Charles Griffin and Co., Ltd., 1920.) Price 21*s.* net.

The addresses and papers given in 1920 at the conjoined meeting of the Faraday, Royal Microscopical, Optical and Photomicrographic Societies and Technical Optics Committee of the British Science Guild are gathered together conveniently in the volume under notice. All the papers are by specialists in their respective branches and the whole constitutes a valuable contribution to microscopical science. The President, Sir Robert Hadfield, in his introductory address traced the history of the development of the microscope, and papers on the earliest steps in the invention of the microscope and on the history and design of photomicrographic apparatus are contributed by Dr. Singer and Mr. Martin Duncan respectively. The future of the microscope is dealt with in suggestive papers by Mr. Barnard and Mr. Schneider, while Profs. Cheshire, Conrady and Porter discuss the mechanical design and optics of the instrument. Many experts in their particular subjects give practical details on the application of the microscope in fermentation industries, in petrology, metallurgy, engineering and metrology. Methods of illumination, the testing of objectives, and optical glass and its manufacture are other subjects dealt with. In addition to the papers themselves, a summary of the discussions following their reading is included and the volume is illustrated with many plates and figures. The work, which has been ably edited by Mr. Spiers of the Faraday Society, is indispensable to any one desiring to follow the trend of the modern developments of the microscope and of microscopical science. R. T. H.

Introduction to the Study of Minerals and Guide to the Mineral Collections in Kelvingrove Museum. By Prof. P. MacNair. Second edition. Pp. viii+94+1 plate. (Glasgow: Hay Nisbet and Co., Ltd., 1921.) 1*s.*

Prof. MacNair is to be congratulated on having introduced many improvements in the second edition of his useful guide-book. The figures illustrating the crystal-forms are much more accurate than those published in the first edition, though there are still a few which should have been replaced. The part dealing with crystallography has been much increased and the systems have been subdivided into groups, the introduction of which in place of the classes of the accepted systems of crystallography is rather confusing.

The guide includes a clear account of the optical and other properties of minerals, a description of some of the commoner species, a glossary of terms, and a list of species in the collection. The book is based very much on the lines of Fletcher's "An Introduction to the Study of Minerals," of which the fifteenth edition is still used as the guide to the Mineral Department of the British Museum (Natural History). It will be noted that Prof. MacNair in Glasgow has produced his book at sixpence less than the price of the British Museum Guide.

The Secrets of the Self. (*Asrár-I Khudi.*) A Philosophical Poem. By Sheikh Muhammad Iqbal. Translated from the Original Persian with Introduction and Notes by Dr. R. A. Nicholson. Pp. xxxi+147. (London: Macmillan and Co., Ltd., 1920.) Price 7*s.* 6*d.* net.

This poem has an interest beyond that of its artistic form or æsthetic content, for it reveals the effect on the oriental mind of contact with the culture and philo-

sophy of the West. The writer is a firm and devout believer in Mahomet. He has studied Bradley and Bergson, he has taken degrees at Cambridge and at Munich, and he has returned to Persia, more ardent than ever in the vision of a world-triumphant religion, an Islamic kingdom of God on earth.

Proceedings of the Aristotelian Society. New Series—vol. xxi. Containing the papers read before the Society during the Forty-second Session, 1920–1921. Pp. iv.+246. (London: Williams and Norgate, 1921.) 25*s.* net.

ALTHOUGH the papers in this volume are philosophical in the technical meaning, several of them are of unusual scientific interest, and all of them show how the results of pure scientific research are influencing philosophical speculation.

Prof. Montague's paper on "Variation, Heredity and Consciousness" is described as a mechanist answer to the vitalist challenge. It develops an ingenious theory according to which it is possible to trace the transformation of the potential energy acquired by the brain, through the kinetic energies of sensory nerve currents, into all the phenomena of mind and consciousness. In the whole process no factor is admitted which is not definable in purely physical terms. The Dean of St. Paul's in his Presidential address "Is the time series reversible?" finds it impossible to keep out Einstein and the principle of relativity. Miss Oakeley gives an excellent critical account of the recent work of Prof. Driesch in "Philosophy of Life and Knowledge." Prof. Boodin in a paper on "Cosmic Evolution" deals with the new theories of the origin and evolution of life of the American biologists, Osborn, Willard Gibbs and Henderson. Dr. Dorothy Wrinch's paper "On the Structures of Scientific Inquiry" is abundantly illustrated with examples from modern research in mathematics and physics.

Tables of Refractive Indices. Vol. xi. *Oils, Fats and Waxes.* Compiled by R. Kanthack. Edited by Dr. J. N. Goldsmith. Pp. 295. (London: Adam Hilger, Ltd., 1921.) 25*s.* net.

IT is satisfactory to find a British firm of scientific instrument-makers not content with manufacturing instruments but, in addition, providing facilities for the compilation and publication of data which will facilitate the use, and incidentally lead to the extended employment of their manufactures. Mr. Kanthack has done his work well, and no one who uses his tables is likely to complain that oils of any importance have been omitted or that the figures quoted are badly selected from those available.

The names of the oils are arranged alphabetically, both native names and scientific names of the sources being given. Wherever possible the constants are quoted beside the native names and cross-references placed against the scientific names. This has two disadvantages: native names are variable, being usually merely attempts at phonetic renderings of native pronunciations and they also vary with the country of origin. Further, the method of arrangement fails to bring together oils which are similar in character, a matter of some importance for convenience of reference. It would be difficult if not impossible to devise an arrangement to obviate these disadvantages entirely, but it would probably improve matters somewhat if the scientific names of the sources of the oils were made the backbone of the arrangement and the native names given in a separate glossary.

The value of the tables to the analyst is enhanced by the inclusion, in separate appendices, of refraction constants for glycerol, glycerides and fatty acids, and "hardened" and polymerised oils, with approximate temperature corrections and factors for the inter-conversion of refractive indices and butter refractometer readings. There is also an extensive bibliography.

T. A. H.

The Distribution of Vegetation in the United States as related to Climatic Conditions. By B. E. Livingston and E. Shreve. (Publication No. 284.) Pp. xvi+590+plates. (Washington: Carnegie Institution). 9 dollars.

THE development of ecology has been much stimulated in recent years by the detailed and exact work of American botanists. The book under notice forms in many respects a companion volume to that of Clements on "Plant Succession." Essentially it deals with the delimitation of vegetational areas in the United States and the relation of these to environmental conditions. Prof. Livingston is well-known for his work in plant physiology, as well as in ecological plant-geography, and Dr. Shreve is also a physiological ecologist. So this aspect naturally dominates in their joint work.

The introduction and the first portion of Part II., dealing with environmental conditions, will be read with interest by all ecologists and physiologists since they contain much useful general information and new standpoints for the survey of old questions. That portion of the book which deals directly with American vegetation shows clear indications of an enormous amount of detailed work. The abstraction and preparation of figures and tables illustrating the very varied climatic conditions of the United States and their correlation with vegetational areas must have necessitated much concentrated labour, and co-nationals of the authors will owe a debt of gratitude to them for the results. Numerous outline maps are reproduced to show graphically the distribution of climatic conditions, vegetational types, and even occasionally of single species. One coloured map showing the vegetational areas of the United States, and another the life-zones, accompany the volume, which is also provided with a table of contents but no index.

W. B. T.

Modern Motor Car Practice. Edited by W. H. Berry. (Oxford Technical Publications.) Pp. xii+582. (London: Henry Frowde and Hodder and Stoughton, 1921.) 31*s.* 6*d.* net.

A LARGE amount of information regarding the details of motor cars and their working in practice will be found in this volume. As a rule, each principal detail, such as clutch, steering gear, etc., forms the subject of a separate chapter. Different designs are discussed and their defects and advantages indicated. The book

is profusely and well illustrated, and forms a valuable compendium for car users. The designer will also find it useful from the same point of view, but as the treatment is non-mathematical throughout, its service to him will be somewhat limited. Whilst the volume is for the most part free from errors, there are some statements regarding resiliency on p. 376 which require revision. The book is up-to-date in general, and includes a chapter on the X-ray examination of materials and another on welding repairs.

My Electrical Workshop. By F. T. Addyman. Pp. viii + 249. (London: The Wireless Press, Ltd., N.D.) Price 7*s.* net.

DESPITE the many complete mechanical contrivances now obtainable which enable boys to construct models by simply using a screw-driver, there is still a large number who prefer to make things for themselves. Those who have inclinations towards electricity will find the volume under notice useful in helping them to produce apparatus which will work and can be made from simple materials, provided they possess some measure of handiness with tools. There is a large number of illustrations which assist in making the text clear, and here and there the real article is described as well as a method of making a model having the same principle.

A Manual of Pharmacology. By Prof. W. E. Dixon. Fifth Edition, completely revised. Pp. xii + 468. (London: Edward Arnold and Co., 1921.) 18*s.* net.

SINCE the publication in 1905 of the first edition of Prof. Dixon's "Manual of Pharmacology," the volume has maintained its reputation as one of the foremost works on the subject, a reputation which it gained by the very practical arrangement of the subject matter and the readily intelligible manner in which it was presented. The fifth edition retains those characteristic features. Very little change has been made in the classification of the drugs discussed; they remain as before in pharmacological groups.

The chief alterations that have been made consist in the insertion of new paragraphs where necessary and in the correction of the text so as to give effect to the results of work that has been carried out by the author and others during the last few years. Several drugs, such as agaricin, allantoin, etc., to which attention has recently been directed, are accordingly considered. Chemotherapy, the conception that the protoplasm of the living cell is provided with receptive side chains to which drugs can attach themselves and so bring the poisonous properties of a toxophore grouping to bear, is, in the author's opinion, based neither on chemistry nor on pharmacology. By the slow oxidation of salvarsan in the blood into a substance containing trivalent arsenic a steady supply of efficient parasiticide is thrown into the blood, the action of the salvarsan being thus only indirectly on the parasite. On the other hand, in the treatment of filariasis, bilharzia and kala-azar by the intravenous injection of soluble antimony salts, these apparently penetrate the embryos or adult parasites and so produce their toxic action. Of the value of twilight sleep in depriving labour of its terrors, Prof. Dixon is by no means convinced; in his view it has still to be determined.

The section on antiseptics and disinfectants has been practically rewritten. The action of hypochlorites on proteids and the antiseptic action of chloramines and their sodium compounds as well as of flavine are concisely but very clearly described. The employment of sunlight, ultra-violet rays, X-rays, and radium emanations as remedial agents is also briefly discussed. There is no doubt that to the student and to the practitioner of medicine, as well as to all who are interested in pharmacology, Prof. Dixon's "Manual" will remain indispensable.

Atomic Theories. By F. H. Loring. Pp. ix + 218. (London: Methuen and Co., Ltd., 1921.) 12*s.* 6*d.* net.

RECENT investigations on the structure of the atom and allied studies have proceeded so rapidly that it is difficult for the average reader to keep pace with the advances. The subject is, however, of absorbing interest, and has such an important bearing on all branches of physics and chemistry, that every student feels the need of making himself acquainted with the main features of the new theories. In the case of chemical students, a non-mathematical treatment is, so far as is possible, desired. Mr. Loring's book, which is attractively printed on good paper, will be found of great interest and value in this connection. Particular mention may be made of the accounts of Rutherford's theory in Chapter VIII. and of Bohr's theory in Chapter X. In some cases, notably Chapter IX., on the Quantum Theory, the treatment is too condensed to be clear. The style in many respects is often at fault; the author shows a tendency to wander in sentences, which leaves one with a confused idea of what he is trying to say. The statements on pp. 6 and 15 that fractional atomic weights ($O = 16$) are due to isotopes cannot be maintained in the face of examples such as iodine and nitrogen.

East Carelia and Kola Lapmark. Described by Finnish Scientists and Philologists. By T. Homén. Pp. xiv + 264. (London: Longmans, Green & Co., 1921.) 21*s.* net.

THE separatist movement in Eastern Carelia dates from the Soviet *régime* in Russia. It has now led, on the one hand, to a Soviet attempt to suppress it by force, and on the other to an appeal by the Carelians to the League of Nations. The present volume, which was originally published in Finnish and later in Swedish, is in a sense a contribution to that movement in so far as it aims, in a series of papers written by experts, to give an account of the country, its products, history, and inhabitants. For this purpose Kola Lapmark, where the Carelians are not in a majority, is included. It was written before the Treaty of Dorpat, 1920, by which a strip of Russian territory ending in Pechenga Gulf was ceded by Russia to Finland, thus disposing effectively of Finnish claims to Kola Lapmark. The propagandist aim of the book, however, does not obtrude and is mentioned only rarely. The volume is a valuable contribution to the geography of Arctic Europe, and is well illustrated by several maps.

R. N. R. B.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Research Degrees and the University of London.

THE question of research degrees in the University of London, which is the subject of a letter by Dr. Morley Davies in NATURE of February 23, p. 238, raises an important matter of principle. The proposal of the sub-committee of the Academic Council of the University to institute a new series of examinations for the M.Sc. degree, appears to have arisen from a desire to secure uniformity in the granting of the degree. Whether it will do so or not is a matter of opinion, but, in any case, many people consider that such uniformity can be obtained only by retrogressive steps, in view of the urgent necessity for the training of research workers.

The examination fever has fortunately died down in recent years. The general raising of the standard of examinations which has accompanied the rapid advances in natural and experimental science has resulted in the Honours B.Sc. Examination becoming not only a searching test of the general knowledge of the principal subject chosen by the candidate, but a severe test of his familiarity with some special branch. Beyond the standard thus set, it is very difficult for an examiner to impose a test without giving a candidate a choice of a large number of highly technical questions either limited in scope or controversial because of the generalities in which they tempt candidates to indulge. Such a type of examination almost puts the examiner at the mercy of an examinee who has the wit to ask in an apostrophic way, "What did Gladstone say in 1876?" or to refer to the rocks of the Amazonian forests or the flora of the Senussi country!

Ostensibly, the undesirability of having four standards of research for the B.Sc. (research), M.Sc., Ph.D., and D.Sc. disturbs the sub-committee. Dr. Davies has dealt effectively with this question. Leaving aside the B.Sc. by research as a qualification granted but rarely and exceptionally, no difficulty as regards the standard for the other three degrees will arise in the mind of many examiners.

May I submit the following as a purely suggestive general scheme of minimum requirements? The candidate should in his M.Sc. thesis show that he is familiar with the literature of his branch of research, and able to summarise and analyse that literature effectively; further, that he has had sufficient originality of mind to pursue a line of inquiry instituted by others, and to extend knowledge in such a direction. For the Ph.D. degree he should be able to make a marked contribution to the advance of knowledge, and to submit a finished account of an investigation or an interim report, complete so far as possible, and containing legitimate deductions, his dissertation bearing evidence of the expenditure of an appropriate amount of time and labour. For the degree of D.Sc., it is desirable that the candidate should display great originality of mind and a capacity for research of a high order. He should be able not merely to use the methods and weapons of others, to extend their fields of investigation and apply their results, but to evolve methods and tools of his own, strike out into new paths, and in turn give a lead to less experienced workers.

If some such distinction as that drawn above is not, even unconsciously, adopted, the matter of the respective standards for the Ph.D. and D.Sc. is likely to become chaotic. If the M.Sc. by examination is instituted an undesirable tendency, already in evidence, for the candidate to proceed direct from B.Sc. to Ph.D. (and there remain) will undoubtedly develop.

As an illustration of an opposite point of view to that taken by the sub-committee, I may perhaps be allowed, without advocating in any way too early specialisation, to commend the scheme adopted in this university of allowing a student (by arrangement of the head of the department concerned) to present, as an alternative to taking one special paper in the Hons. B.Sc. Examination, a report upon some piece of investigation carried out by him.

P. G. H. BOSWELL.

University of Liverpool, March 7, 1922.

Phenological Observations.

THE highly interesting communication of Mr. J. E. Clark in NATURE of February 16 directs attention to some important problems in phenology, and I beg space to indicate one or two that have more especially occurred to me.

First, in the comparison between England S.E. and England S.W., I do not think the earlier flowering of horse-chestnut (*Æsculus hipp.*) around London than in Cornwall is at all a surprising result, inasmuch as the climate of Cornwall with its rough sea gales is notoriously unfavourable to trees (except, perhaps, in the deeper valleys) as distinct from herbaceous plants. It may also be that the more rapid rise of temperature in the south-east of England than in the oceanic south-west peninsula acts as a stimulus to the spring flowering of certain trees.

Secondly, I am anxious to urge the desirability of correlating the autumnal phases with the spring phases of vegetation in studying the effects of climatic conditions upon the seasonal phenomena of plants. Let me illustrate the point by an example, that of our native oak (*Quercus robur*). According to Hopkins's "bio-climatic" law, the oak should burst into leaf and flower a week to ten days sooner in southern than in northern England, and this certainly agrees pretty well with general experience. But is it safe, therefore, to infer that because the oak puts forth its leaves a week or so earlier in the south of England in response to a warmer climate, it will shed them a week *later* in response to the same? Consider the opposing factors that appear to be at work. In studying individual oaks of the same locality in diverse parts of the country I have constantly noticed that those trees in autumn which are in full tint, or are half bare, are usually such as have already ripened their acorns, whereas those of which the leaves are still green have not yet matured the acorns.

Now if one may apply this generalisation to the comparison between the north and south of England it would appear that, on the one hand, colder climatic conditions will tend to cause earlier defoliation in the north, and, on the other hand, that internal biological conditions will tend to delay defoliation in order that the acorns, the flowers of which were ten days behind the south to commence with, may be brought to maturity. But the generally more inclement conditions in the north, with the earlier night frosts, are impatient of any delay in the fall of the leaf, and it becomes a question of the utmost interest how the average dates of defoliation in the north and south of England actually do compare with those of foliation. One knows that the northern limit of the British oak as a flourishing species is set somewhere about the middle of Scotland, and presumably the critical determining fact is a summer too cold and short for fructification.

Thirdly, in the complex study of phenology the influence of factors other than meteorological should ever be borne in mind, as was brought to the attention of the Royal Meteorological Society last year by

Dr. E. J. Salisbury in a paper published in conjunction with the Phenological Report for 1920 (Q.J.R. Meteor. Soc., October 1921).

The average dates of leafing, flowering, etc., of a particular species is the result of *prolonged* adaptation to climate, and whilst the deviations of particular individuals from that date is controlled in part by local conditions of habitat, etc., the deviations of the same individuals in different years are governed not only by the weather of the current season but also by that of the previous season. The deviations from year to year are really kept within remarkably narrow limits, and there can be no doubt that force of habit is all-important in causing the periodic processes of vegetation to occur as near to the same dates year by year as external meteorological vicissitudes will permit. L. C. W. BONACINA.

27 Tanza Road, Hampstead, N.W.3, March 12.

The Resonance Theory of Hearing.

DR. PERRETT will, I hope, excuse me if I have seemed to impute absurdities to him (NATURE, February 9, p. 176). My reason for replying to his letter was because it seemed to me unfair to the resonance theory to leave his criticism unquestioned. But perhaps the consideration of an example will help to bridge the difference of opinion between us. Prof. Millar in his "Science of Musical Sounds" has given, on p. 201, analyses of the intensities of the harmonics of the oboe and clarionet. Whereas the clarionet note has harmonics of which the 8th, 9th, and 10th are the strongest, in the oboe note, on the other hand, the 4th and 5th harmonics have the greatest intensity If, then, the ear heard both these instruments sounding the same tone at one and the same time, it would hear one fundamental accompanied by strong 4th, 5th, 8th, 9th, and 10th harmonics.

Now no musical instrument of which Prof. Millar gives the analysis has these harmonics strongly marked, and the chances are enormously against any *one* musical instrument whatever having precisely the same intensities of the harmonics as those of the oboe and clarionet sounding the same tone together. In other words, there is something quite unique about the harmonics in the case that I have taken, which should enable the observer to say that the sound is to him not like an oboe only, or a clarionet only, but as if an oboe and a clarionet were speaking the same tone at the same moment. Now I do not say that the ear can never be deceived, for Helmholtz himself showed that vowels even, can be imitated by means of tuning-forks, but it seems to me that the characteristic intensities of harmonics do in almost all cases enable an observer to recognise the sounds of different classes of musical instruments even when any two of them are playing the same tone. Let us turn finally to the case which Dr. Perrett mentions, namely, when the voice is accompanied by the same tone produced by the chattering teeth. We know from the works of Helmholtz, Millar, and many others that the voice overtones have one maximum of intensity for the vowels "o" and "a" and two maxima for "e," "i" and "u," other overtones being very weakly represented. We also know that discontinuous sounds, such as those produced by tooth striking tooth, are very rich in overtones, and that these do not occur in maxima in any definite way. We should, therefore, expect the voice and the teeth-sound to have overtones very different in their intensity distribution. Therefore the observer should, so far as one can judge, hear overtones as characteristic on which to base his judgment, as those given out by oboe and clarionet.

I must, therefore, repeat that, in my opinion, Dr. Perrett is mistaken in his objection to the resonance theory. H. HARTRIDGE.

King's Coll., Cambridge.

Snow Furrows and Ripples.

WHILE at Gstaad recently, after a fine fall of snow (about 24 inches), the Föhn blew and rain fell for some hours. The weather then cleared, the temperature falling below freezing-point, and the snow then presented the appearance shown on the accompanying picture (Fig. 1). The peculiar "silloné" appearance of the snow on the slopes is very striking. It looks as though water had run down over the surface, but this did not happen during the rain or afterwards.

FIG. 1.

As to the origin of the "furrows" (sillons), I think they were caused by contraction of the snow, as the gentle rain wet the fine-grained snow particles and drew them together. I observed afterwards the same development of furrows during fine weather on sunny slopes. These were so shallow that I failed to photograph them, but the whole hillside was covered with them. I also noticed that they occurred on the low-lying flat meadows, although they had no particular orientation in that case and occurred in every direction. This may be discerned in the lower parts of Fig. 1. E. C. BARTON.

I WAS once out on the snow-covered prairie at Moose Jaw, Saskatchewan, when suddenly, the hot chinook wind began to blow, the counterpart of the Alpine föhn. The snow melted away with astonishing rapidity, and very soon there was the sound of trickling water, which I had not heard for months, for the season was late winter. The melting was not uniform, nor did it produce longitudinal furrows, but on the contrary a rippled structure of ridges and furrows transverse to the wind, adding yet one more variety to the many kinds of ripples which I had seen in snows of different consistency.

VAUGHAN CORNISH.

Historical Notes upon Surface Energy and Forces of Short Range.

By W. B. HARDY, Sec. R.S.

THE following notes were completed about fifteen years ago for a purpose not now likely to be fulfilled. They seem worthy of publication because the early history of the subject, which is to be found in Clerk Maxwell's essay on "Capillary Action,"[1] and is based upon a report made by Challis to the British Association in 1834, seems to be wrong in material points. Challis does less than justice to the eighteenth-century philosophers.

According to Poggendorff, Leonardo da Vinci must be considered as the discoverer of capillary phenomena, but a fact so patent to all can scarcely have been discovered by a single man. The ascension of water and other liquids in capillary tubes was "noticed by the Academy del Cimento at Florence early in the seventeenth century, but seems not to have been much regarded in the sequel."[2] Communications to that academy were anonymous. Probably Leslie's authority was "une anecdote curieuse qui a été publiée par M. Nelli ('Saggio di storia letteraria,' etc., p. 92) sçavoir que le véritable auteur de cette expérience fut Nicolas Aggiunti, mort le 6 décembre, 1635 . . . l'un des Fondateurs de l'Académie del Cimento."[3]

The beautiful volume issued by the Academy in 1667 is devoted mainly to experiments in a vacuum. Amongst these is a demonstration of the rise of fluid in a capillary tube *in vacuo*.

The phenomenon was still novel when Boyle demonstrated capillary rise "to the no small wonder of various mathematicians."[4] Boyle tried, but failed, to observe whether the rise took place in a vacuum, and he also inquired why the capillary surface should be concave with water and convex with mercury.

If Leslie is to be trusted, the revival of the subject was part of that great revival of physical experiment which followed the promulgation of the Newtonian system at the close of the seventeenth century. At any rate, though Hauksbee was the first whose published work needs consideration, he was not the first to make experiments, for he writes of many attempts to "solve this Appearance. . . . Some have argued from the impeded or diminished Action of the Air,[5] others from the Innixion or Resting of the Parts of the Fluid on the Pores and Asperities of the Glass; others again from the Congruity and Incongruity of the Parts of Matter one to another."[6]

Argument was direct and frequently personal in the pamphleteering times of the eighteenth century, and Hauksbee goes on to say that the "First two ways of solving the Difficulty have this advantage above the other, that they are perspicuously False; whereas this latter is more mysteriously so . . . because of the hard Words of Congruity and Incongruity."

Nothing tangible has survived from these earliest discussions, and we begin the subject with Hauksbee, whose merit was twofold; he was an exact experimenter, and he succeeded in interesting Newton in the problem. His first paper appeared in the Philosophical Transactions for 1709. This led Newton himself to make experiments, and it is a nice question how far the speculations concerning the constitution and intimate forces of matter which appear in the incomparable[7] thirty-first query are owing to his attention being thus directed to the problem of cohesion. The thirty-first query appeared for the first time in the second edition of the "Opticks" of date 1718. Be this as it may, though exact experiment and induction begin with Hauksbee, what may be called in eighteenth-century phrase the philosophy of the subject begins with Newton.

Hauksbee experimented with capillary tubes and also on the rise of fluid between planes of glass, marble, and metal. As fluids he used water, alcohol, and various oils. He noticed that the phenomenon of the rise of fluid in small spaces is not peculiar to one fluid or one solid, and that it is not due to the presence of air, since the rise occurs in a vacuum. His most important experimental result was that the height to which fluid rises is the same in two tubes of the same diameter, but one "at least ten times as thick as the other." Comparing this with the magnet, which can be broken into smaller and smaller pieces each of which will exert the force, he argues that the attraction of the solid for the fluid is limited to the surface of the solid.

There the matter was allowed to rest so far as the paper of 1709 is concerned. In the paper of 1711 the movements of a drop of oil of oranges between two glass planes inclined to one another at an angle are rightly referred to variations in the area of the surface of contact between fluid and solid, but the statement that the power of attraction must increase in proportion to that surface cannot now be defended. His papers of 1712 and 1713 are devoted to careful measurements of the curves which the surface of water forms when enclosed between glass planes. Brooke Taylor in 1712 had already pointed out that the curve was an hyperbola.

There is little theory in Hauksbee's papers. He was essentially an experimenter,[8] but in his book he draws certain definite conclusions from his experiments for which he has not received due credit.

"That very great Man, Sir Isaac Newton (the Honour of our Nation and Royal Society), has set both these Laws of Attraction in a very clear Light"—namely, that amongst the greater bodies of the universe the attraction decreases reciprocally as "the Squares of the Distances do encrease," and that the smaller portions of matter tend to each other by a law very different and unknown, but one according to which the "attractive Forces do decrease in a greater proportion than that by which the Squares of the Distances do encrease." Hauksbee then goes on to make this

[1] "Encyc. Brit.," 9th edition.
[2] Leslie, Tilloch's *Phil. Mag.*, vol. 14, p. 194, 1802. This academy was perhaps the first such body devoted to natural science, though it is stated by Vasari and others that da Vinci founded one at Milan. It was active in Florence during the years 1657–67, and deserves remembrance for the quality of its work.
[3] *Journal des Sçavans* (Amsterdam), November 1768, p. 74.
[4] "New Experiments, Physico-mechanical." (London, 1682.)
[5] [*E.g.* Hooke.]
[6] Hauksbee, "Physico-mechanical Experiments," p. 156. (London, 1709.)
[7] "Our Incomparable President," Jurin, 1718. Also Halley wrote concerning the "Principia" in 1686, "an incomparable treatise on motion."
[8] "There's no other way of Improving Natural Philosophy but by Demonstrations and Conclusions, founded upon Experiments judiciously and accurately made."

perfectly definite statement that "the attractive Power of small Particles of Matter acts only on such Corpuscles as are in contact with them, or removed but infinitely little Distances from them," thus anticipating Segner by nearly half a century.[1]

Obviously, it follows that (in anticipation of Clairaut) the water in the interior of capillary tubes is held up by the attraction of the particles of the walls of the tube, to those particles of water at the surface which are "urged strongly towards the Glass." Lastly, Leslie was not the first to show that the attraction is everywhere normal to the surfaces of the solid, as Maxwell states, for Hauksbee says: "The Parts of the Liquid adjoining to the concave Surface of the Tube are strongly attracted by it, and that in a Direction perpendicular to the sides of the Cylindrick Glass."

A comparison of contemporary references with the actual writings of Newton leads to the conclusion that much which is attributed to him was made public verbally during the discussions at the Royal Society. An interesting instance is furnished by the note to Dr. Jurin's paper.[2] At any rate, the hints scattered through the Queries to his "Opticks" as to the existence of forces acting between the particles of matter "which reach to so small distances as hitherto to escape observation," and which sprang in the first instance from his study of the diffraction of light, became a compact body of doctrine accepted in England before 1720. Hauksbee, as we have seen, wrote in 1709, nine years before the thirty-first Query was published, of intermolecular forces of insensible range, which fall off according to some higher power than the square of the distance, and Jurin in 1719 speaks of the "universally acknowledged" attractive force between the particles of a fluid (water), and refers to the sphericity of drops of rain, and the fusion of drops of water when in contact, as examples of the operation of the force; in both cases reference is made to Newton.

This doctrine, which, I believe, was shaped by the discussions at the Royal Society, may be embodied in a series of propositions as follows :—

(1) That, in addition to the force of attraction which acts between larger bodies and varies in intensity according to the inverse square of the distance, there is another attractive force which acts between the ultimate particles of matter, has a range of insensible magnitude, and varies inversely according to some power of the distance higher than the square.

(2) At distances less than a certain minute value this attractive force gives place to a repulsion.

(3) The attractive force "performs the Chymical Operation"; it is the source of cohesion, and cohesion brings about the movement of fluids in small spaces.

(4) Heat is a quality of matter, not a substance. It is the agitation of the particles of matter, and if "the Heat is big enough to Keep them in (adequate) Agitation, the Body is fluid."

(5) The ultimate particles of matter are of definite shapes—not always spheres—and are impenetrable.

Dr. Jurin, secretary of the Royal Society during a portion of Newton's term as president, was led to the subject of capillarity by "an ingenious Friend" who proposed a plausible method for "making a perpetual Motion" founded upon Hauksbee's experiments. The method is of little interest, but Jurin was led directly by it to the discovery that the height to which fluid is raised is determined by the "periphery of the tube to which the upper surface of the water is contiguous," and he argues that, as this is the "only part of the tube from which the water must recede upon its subsiding," it is consequently "the only one which by the force of its cohesion or attraction opposes the descent of the water." Hence the rise must be inversely proportional to the diameter of the tube. Newton and Machin pointed out that Jurin's "'periphery' . . . is really a small surface, whose base is that periphery (of the tube), and whose height is the distance to which the attractive power of the glass is extended."[3]

In the interval between Jurin's papers a book appeared "by a very learn'd and ingenious member of this [the Royal] Society," whose name I have not succeeded in tracing. It deserves mention because in it the effect of the attractive power of the water for itself is exactly considered. Jurin demonstrated the attraction in a striking manner when he showed that if the tube at the lower part of a funnel is drawn out to capillary dimensions and the funnel inverted with the open mouth under water, then if it be filled by drawing water up into the capillary it will remain full. The experiment succeeded in a vacuum. He infers that the lower mass of water in the funnel must be suspended by its cohesion to the column within the capillary. At the end of the memoir is a series of propositions, of which Nos. 4 and 6 assert that the particles of water are more strongly attracted by glass than by each other, but the particles of quicksilver are attracted more strongly by each other than by the glass—hence the rise of water and the depression of quicksilver in a tube.

Though the theories of Hauksbee and Jurin were generally adopted—as, for instance, in the memoirs of Bilfinger[4] and Weitbrecht[5]—there was a body of opinion which contested the existence of attractive forces of cohesion.[6]

The cause of this widespread interest and discussion of capillary phenomena in the eighteenth century cannot be better stated than in the words of the astronomer, de la Lande[7]: "Many phenomena are regarded as allied to those of capillary tubes, . . . *e.g.* the suction of sugar and of sponges, the origin of springs in elevated sites; the secretions in the human body seem to be due to the same cause. . . ." These phenomena illustrate the general attraction of matter, contested too long. "Capillary tubes put into our hands an obvious example of the generality of this law, which is the keystone of physical science." But M. de la Lande's attempts to explain the phenomena were not very illuminating!

In the eighteenth century the force of cohesion was so closely identified with chemical action that Guyton

[1] Maxwell therefore is wrong in saying that "these early speculators . . . do not distinctly assert that this attraction is sensible only at insensible distance."

[2] Phil. Trans., 355, p. 739, 1718.

[3] Phil. Trans., 1718, p. 747.

[4] *Mémoires de l'Acad. de St-Pétersbourg*, vols. 2 and 3, 1727–28.

[5] *Ibid.*, vols. 8 and 9, 1736–37.

[6] *E.g.* Paulian, "Traité de paix entre Newton et Descartes," vol. 3, p. 199; Gerdil, "qui a fait un Livre tout entier contre l'attraction des Tubes Capillaires"; Abat and others. Mairan, who explained cohesion as being due to electrical action, etc.

[7] *Journal des Sçavans* (Amsterdam), vol. 35, November 1768, p. 75. De la Lande, in his system of astronomy, incorrectly refers his own paper to the October number.

de Morveau, for example, in 1773, in his examination of the nature of chemical affinity, attempted to determine the relative affinities of a variety of substances from the force required to detach small plates of glass from their surfaces.[1] The experimental method was investigated mathematically by Laplace and Duprè, and used widely as a means of measuring surface tension.

Though the range of the force of cohesion was recognised as being insensible by these earlier writers, nowhere, so far as I know, did they draw the conclusion that the surface layer of a fluid must be the seat of special forces, though a strong hint appears in Newton's comments upon Hauksbee's experiments. The enunciation of the secondary principle of surface tension was reserved for Segner.[2] Segner appears to have had little or no acquaintance with other work on the subject; he refers only to Clairaut ("Figure de la Terre," 1743), whose book, however, he could not obtain ("quesitum nancisci non potui"): "Cupiebam autem inspicere, propter articulos quasi episodicos . . . rotunditatem guttarum . . . elevationemque et depressionem fluidorum in tubis capillaribus, spectantes. Ea ergo qualia sint, quantumque cum meis consentiant, dicere nequeo." The subject matter of Segner's paper is, in the first instance, the equilibrium of drops of fluid; the equilibrium in tubes is treated from the point of view of the curvature of the free surfaces. The important theorems are Nos. 2 and 3, which assert that if in any drop the volume be divided into a shell, the thickness of which is that of the range of the force of attraction, and an interior mass, the forces on any particles in the latter contribute nothing to determining the form of the drop, but only those forces on any particles in the surface shell which can be resolved along the normal to the surface and in the tangent plane. In his calculations of the effects of the surface tension so produced Segner made the mistake, afterwards corrected by Laplace, of taking account only of the curvature of a meridian section of the drop, neglecting the effect of the curvature in a plane at right angles to this section. To Segner, however, belongs the credit of being the first to deduce the phenomena of capillarity from the surface tension.

The existence of a surface tension was demonstrated objectively when Leidenfrost showed, in 1756,[3] that a soap bubble tends to contract. In 1787 Monge[4] applied the principle to explain the apparent attractions and repulsions between bodies floating on a liquid.

Reference is made by Leslie (see later) to experiments on the subject made in Holland by Musschenbroek. I have not succeeded in tracing these. The only reference in his "Cours de Physique" of 1769 is to the experiments of Hauksbee, and theory is limited to the statement that "l'explication se présente naturellement à l'esprit"![5]

Leslie, in a curiously polemical and pedantic paper,[6] attempts to replace Jurin's "explication" of the rise in capillary tubes, which "is almost universally adopted. It is repeated in all the elementary books of natural philosophy." The attraction of the glass, everywhere normal to the surface and of narrow range, gives rise to an increase in pressure in the layer of water next to the surface of the glass. The result of this pressure is that a drop of water tends to spread out over the surface of the glass and consequently to mount upwards in a tube. "But why should the mere tendency of the water to the surface of the glass occasion a dispersive motion? The reason is that the external particles could not approach without spreading themselves and extending the film: and analogy will instruct us, that the attraction of water to glass must increase in proportion to the proximity of its approach." The liquid film flows up the walls of the tube, carrying with it water which adheres to it, and equilibrium is reached when the weight of the column balances the force by which the film spreads itself over the glass. "This explanation of the action of the solid is equivalent to that by which Gauss afterwards supplied the defect of the theory of Laplace, except that, not being expressed in terms of mathematical symbols, it does not indicate the mathematical relations between attraction of individual particles and the final result."[7] Maxwell gives to Leslie the credit of being the first to explain correctly the rise of fluid in a capillary tube. "He [Leslie] does not, like the earlier speculators, suppose this attraction [of the solid] to act in an upward direction so as to support the fluid directly." Yet a few pages further on Maxwell himself speaks of the tension of the solid as though it intervened actively as an upward pull!

On few subjects has more been written than on capillarity, and yet the exact way in which the attractive forces act in causing the rise of fluid in capillary tubes and the spreading of fluids over solid or fluid surfaces is still obscure. Leslie's account is probably the best, and if true it carries an important corollary—namely, that the layer of fluid attracted by the glass is at least two molecules in depth. Recent writers, if I understand them rightly, would restrict the influence to a layer only one molecule deep.

Leslie's paper is original and powerful, and even now very little out of date. It includes many observations which are still of great interest; of these the only one I have space to mention is the discovery of the fact that the "assimilation" of fluid by porous bodies is accompanied by a rise of temperature. He was, I believe, the first to detect this fact.

In the early years of the nineteenth century the subject received attention at the hands of two remarkable men—Dr. Thomas Young and the Marquis de Laplace. Their methods were entirely dissimilar. Young founded his theory on the principles of surface tension, or "superficial cohesion," as he calls it. "Since the time of Segner," he says, "little has been done in investigating accurately and in detail the various consequences of the principle." He begins by making two assumptions—the first, which he attributes to Monge "and others," that the cohesive attraction of the superficial particles causes the free surface of fluids to "be formed into curves of the nature of lintearïæ which are supposed to be the results of a uniform tension of a substance"; and the second, "which appears to be new," that the angle of contact

[1] He used "la méthode du Docteur Taylor [Brooke Taylor] . . . qui, par le choix des matières employées, peut servir à faire connoître que l'attraction que les Chymistes nomment affinité a nécessairement quelque part à cette adhésion," *Jour. de Physique*, vol. 1, p. 172, 1773.

[2] "De Figuris Superficierum Fluidarum," Comm. Soc. Reg. Sci. Gottingensis, vol. 1, p. 301, 1751.

[3] "De aquae communis nonnullis qualitatibus tractatus." (Duisburg.)

[4] *Mémoires de l'Acad. des Sciences*, p. 506, 1787.

[5] Pencilled on the margin of my MS. is the note "Not altogether just." At this distance of time I cannot elucidate the remark.

[6] Tilloch's *Phil. Mag.*, vol. 14, p. 193, 1802.

[7] Clerk Maxwell, art. "Capillary Action," "Encyc. Brit.," 9th edition.

of a liquid surface and a solid is constant and characteristic of any given pair of liquids and solids.

If a curved line is equally stretched, the force that it exerts along the normal at any point is directly as its curvature, and the same is true of a surface of simple curvature—*e.g.* a cylindrical surface. When the curvature is double, each curvature has its appropriate effect, and the normal force will vary as the sum of the curvatures. As this sum is the same for all perpendicular directions, the normal forces will be proportional to the sum of the greatest and least curvatures. Since the force is always directed to the centres of curvature it will elevate the fluid in a capillary tube when the surface is concave, and depress it when convex. When the surface is cylindrical and therefore curved only in one direction, as when water rises between two glass plates, the curvature must be everywhere as the height of the volume of fluid. When the curvature is double, the sum of the curvatures must be as the ordinate. This is the relation expressed by Laplace's fundamental equation, and Young's essay[1] contains the solution of most of the cases afterwards solved by Laplace. Peacock, Lowndian professor at Cambridge from 1836 to 1858, the editor of the Works of Young, appends the following note: "In the original essay the mathematical form of this investigation and the figures were suppressed, the reasoning and the results to which it leads being expressed in ordinary language; even in its altered form the investigation is unduly concise and obscure." Clerk Maxwell says of Young's methods of demonstration that, "though always correct and often extremely elegant [they] are sometimes rendered obscure by the scrupulous avoidance of mathematical symbols."

The phrase "scrupulous avoidance" is quoted from Challis and is applicable only to the earlier essays. In the article on cohesion of 1816 and the "Elementary Illustrations of the Celestial Mechanics of Laplace," mathematical symbols are freely used, the analysis being by the method of fluxions. Owing to a charming devotion to Newtonian tradition, English mathematics was at its lowest ebb when Young was a student at Cambridge; the reforms which Woodhouse, of Caius, within a few days of the same age as Young, initiated in the Cambridge School in 1803 bore fruit only in 1817, through the action of Herschel, Babbage, and Peacock. A poor training in antiquated methods and a certain vanity in his powers of "clear and simple explanation,"[2] may account for the way in which Young concealed his mathematics. His spirited indictment of the "algebraical philosophers, who have been in the habit of deducing all these quantities from each other by mathematical relations, making, for example, the force a certain function or power of the distance, and then imagining that its origin is sufficiently explained," and of the geometricians who "convert the formulæ into a curve with as many flexures and reflections as the labyrinth of Dædalus," is of the earlier period[3] and probably traceable to his personal irritation with Laplace, whom he never forgave for a real or fancied appropriation of his (Young's) ideas.

[1] Phil. Trans., 1805.
[2] *Cf.* the sentence, pregnant with personal character, which closes the essay of 1804.
[3] Lecture 49 of the "Natural Philosophy," the preface date being 1807; p. 471 of the edition of 1845.

Young proceeds to consider the "Physical Foundations of the Law of Superficial Cohesion." This he finds in the nature of the forces of cohesion. Young's work, and especially his "wonderful speculation," as Rayleigh calls it, as to the magnitude of the pressure in the interior of water due to corpuscular forces, which he puts at 23,000 atmospheres, and the calculation based on this estimate of the range of the cohesive force and the size of molecules, are fully dealt with by that writer.[4]

The beginnings of Laplace's well-known theory are to be found more than half a century earlier in the work of Clairaut.[5] Clairaut, like Laplace, was an astronomer, and his treatise on the figure of the earth consists of a mathematical analysis of the condition of equilibrium of fluid masses. This leads to the proposition that "all the particles of a mass of fluid can be in equilibrium amongst themselves when the force which acts on it is the sum of the attraction which they exercise on one another, (namely) gravity, and the attraction of any body which touches the mass." Capillary phenomena are treated as a special case of the proposition. Clairaut's analysis of fluid equilibrium is based upon a consideration of the forces acting upon an infinitely narrow canal of any figure which traverses the mass. The value of the method is that it leads very directly to equipotential surfaces. In the special case of the rise in a capillary tube the canal starts from the meniscus and ends on the general surface of the fluid.

The force of attraction of glass for water is assumed to be the same function of distance as that of water for itself, and to differ only by coefficients of the intensities. Since the range of the force is small (not insensible), only the integrals of the attractive forces about the ends of the tube need be considered. The sum of these must balance the difference in the weight of the limbs of the capillary tube.

The integral of the forces acting on that end of the tube which is at the general surface of the fluid will clearly be equal and opposite to that of the forces on the fluid below the tangent plane to the meniscus; therefore the weight of the column within the capillary is supported by the whole attraction of the fluid of the meniscus above the tangent plane, and of the lower end of the glass tube on the parts of the canal within its range. This result differs from that of Laplace because, though Clairaut assumed the range of the force of attraction to be small, he did not make it insensible. Had he done so he would have got rid of the attraction of the lower end of the capillary tube on the axial canal and have arrived at substantially the same result as Laplace.

Many workers contributed to the subject in the nineteenth century. The curious may find a brief summary of their experiments and conclusions in the papers by Charles Tomlinson which appeared, mainly in the *Philosophical Magazine*, between the years 1870 and 1880. Specially interesting are the speculations from those of Volta onwards as to the cause of the movements of particles of camphor and of other volatile solids on water. Challis's account of Gauss's important memoir cannot be bettered. The substance of it is reproduced by Clerk Maxwell in the article on capillarity which he wrote for the "Encyclopædia Britannica."

[4] Rayleigh, *Phil. Mag.*, vol. 30, 1890, p. 285.
[5] "Théorie de la Figure de la Terre." (Paris, 1743.)

Parasitic Worms of Man and Methods of Suppressing Them.

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One of the most interesting and important groups of the animal kingdom is that of the parasitic worms or helminths; interesting from the point of view of pure science on account of the intricate and varied nature of their life-histories and biological relationships, and important from the effects which they produce on the health of man, domestic animals, and cultivated and useful plants. In the present article a summary is attempted of the results of modern research on the helminths attacking man alone.

The more important helminths attacking human beings can be grouped as follows: (1) the intestinal worms, such as the roundworm and the hookworms, (2) the trematodes or flukeworms, and (3) the filarias and their allies, which live in the connective tissues.

The roundworm (*Ascaris lumbricoides*) and the hookworms (*Ancylostoma duodenale* and *Necator americanus*) live in the small intestine of man. The former is an animal of considerable size, from 20 to 35 mm. in length, while the latter two are smaller, 10 to 13 mm. long. The sexes are separate in all of them, and the females pour out a stream of eggs which are passed out of the human body in the fæces. The eggs ultimately find their way to the surface of the soil, and if the conditions are favourable—*i.e.* if the ground be moist and the temperature not less than that of a European summer (for Ascaris) or of an Egyptian summer (for Ancylostoma)—a small embryonic worm appears within the tough shell. The hookworm larvæ now hatch and lead a free life in mud or in small puddles or pools. Their attack on man is direct and active, for, should the hands or unshod feet come into contact with the mud or water which they inhabit, the little needle-shaped larvæ are roused to great activity. They bore their way through the skin into the subcutaneous tissue, and are carried in the lymph-stream and blood through the heart to the lungs; from the lungs they swim up the air passages and down the œsophagus, so reaching the small intestine. This remarkable life-history was worked out by the Austrian zoologist Looss in Cairo, and, although at first received with some scepticism, it has now been fully confirmed.

In the roundworm, on the other hand, the egg must be swallowed before it will hatch, and this accident (unfortunate from man's point of view) takes place through the consumption of vegetables grown on infected soil, on which eggs have been splashed, or as the result of eating with unwashed hands after working on contaminated land. When the egg arrives thus passively in the small intestine of man, it hatches, and a little larval worm emerges. Until recently it was supposed that this larva remained in the small intestine and simply grew to adult size without further adventure, but the present writer has been able to show that this is not so. The larva bores into the wall of the bowel, enters a vein, and, passing through the liver and heart in the bloodstream, reaches the lungs; from the lungs it migrates to the intestines by a route similar to that adopted by the hookworm.

In the hookworm one object of the migration is obvious, since the larva is merely taking the most sure and direct route to its goal—that is, from the first point at which it comes into contact with man, be this the skin of hands or feet, or of any other part of the body, to the small intestine. It is true that from the finger-tips it might be carried to the mouth and so reach the intestine directly, but only a small percentage of those larvæ which have succeeded in finding man could count on this fortunate chance. By skin penetration, on the other hand, a high percentage should succeed, and it must be remembered that only a few of all the larvæ which have hatched ever succeed in finding man, while only a few of the eggs reach such favourable surroundings as allow the larvæ to form or to hatch.

There is, however, a second object for the migration of the hookworm, the one which is the only motive in the case of Ascaris—namely, that the young larva is not adapted to survive among the strong digestive juices. The young Ascaris lacks not only a stout cuticle, but also that power of chemical defence by which the older parasite resists digestion by its host. Both cuticle and constitutional resistance are developed during the migration, while the larva is being nursed by the blood and lymph, by the bland and nourishing juices of its host. It seems that direct invasion through the skin was the line of attack by the primitive ancestral parasitic worms, and that the present physiological necessity of the migration is due to inheritance.

In geographical distribution *Ascaris lumbricoides* is cosmopolitan, occurring in all lands both temperate and tropical. The hookworms are also very widely distributed, being absent only from the colder parts of the temperate zones. Even there they occur sporadically in artificially warm situations, such as mines and tunnels; the well-known outbreaks of "miners' anæmia," both in the mines of England and the Continent, *e.g.*, in the St. Gothard tunnel, were due to this cause. The proportion of the population affected, especially in the tropics, is extraordinarily high, figures of from 40 to 98 per cent. having been recorded in various countries from the examination of large numbers of the populace. The degree of infestation is highest in the Far East—in China, Indo-China, the Dutch East Indies, and particularly in the tropical Pacific islands. The West Indies and tropical South America also return high percentages, while the southern States of the American Union yield figures which prove that it is not only among dark-skinned races that the parasites become very numerous. Even in Europe 20 per cent of the adult population of Italy and one-half of the children of Central Europe carry the roundworm.

The flukes are flattened oval worms which live in the veins of the abdomen (Bilharzia), in the bile-ducts and gall-bladder (Clonorchis), and in the tissues of the lungs (Paragonimus). Bilharzia occurs over large areas of the tropics and sub-tropics. Three species are known from man, one of which occurs in Mesopotamia, Egypt, and East Africa, the second in Central and South America, the West Indies, and West Africa, and the third in Japan, China, and the Philippines. The association of the West Indies and South America

in one geographical area with West Africa also occurs in the distribution of *Necator americanus*, but is due, not to an old Atlantic connection between the two continents, but to the spread of African parasites to America by the slave trade. In Egypt more than one-half of the population are affected by Bilharzia. Clonorchis and Paragonimus are limited to the Far East—Indo-China, the Philippines, China, and Japan.

The life-histories of all the flukes are similar. The eggs are passed out with the fæces, and if they reach water, the embryos which they contain emerge and swim about actively in search of some particular small mollusc (the intermediate host) into which they must penetrate in order to undergo their first metamorphosis. The intermediate hosts are different in various countries, and for the several worms concerned; for Bilharzia, in the Far East, it is the small water snail, *Katayama nosophora*. This fact was first established by Miyairi and Suzuki, and was confirmed by Leiper and Atkinson; later Leiper and his colleagues identified the intermediates in Egypt as *Bullinus contortus*, *B. Dybowski*, and *Planorbis Boissyi*. From the snail Bilharzia escapes as a more advanced free-swimming larva, which can bore through the skin of man should he venture into infected waters, and, once within the body, it migrates through the tissues to the veins of the liver and abdomen.

For Clonorchis and Paragonimus the first intermediate host is also a small snail, *Melania libertina*. They do not transfer themselves directly and actively from this animal to man, but to a second intermediate—Clonorchis to various species of carp, and Paragonimus to freshwater crabs. In these animals, the second intermediate hosts, they remain passive until they are swallowed by man in food.

The filarias are long, threadlike worms which live in the connective tissues of various regions of the body. They are associated with the disease known as elephantiasis. Geographically they are spread throughout the whole of the tropics. The larvæ circulate in the blood in enormous numbers, and are taken up by blood-sucking insects, in which they grow in size; after the lapse of several days they wander into the proboscis, from which they are injected into the skin of man when the infected insect again feeds. The pioneer work on this subject was done by Manson, and later extended by Low, James, and Leiper. The most important species are *Filaria Bancrofti*, the larvæ of which are carried by various mosquitoes (Culex, Anopheles, and Stegomya), and *Loa loa*, carried by the mangrove fly Chrysops.

The guinea-worm, *Dracunculus medinensis*, is common in India, Turkestan, Persia, Arabia, and tropical Africa. It lives under the skin, and when mature gives rise to a small ulcer, generally on the leg or foot, from which one end of the worm projects. A stream of larvæ is discharged through this ulcer into water when the patient bathes. The next stage of its life is passed in a water flea, Cyclops, and it is by drinking water containing these minute crustacea that man is infected.

Apart from local disease such as abscesses, elephantoid swellings, hæmaturia, etc., the more important helminths produce generalised disease of a very important nature which is surprisingly uniform, whatever be the causal animal. The primary symptom is always anæmia, and the secondary symptoms are such as accompany this condition, namely, general weakness, inability for work or any exertion, disturbance of the heart and circulation, and finally dropsy and death. In mild cases, which fortunately are the most common, the anæmia is not great, and the patient is merely reduced to a lower level of activity, happiness, and efficiency. But when we consider the enormous prevalence of these pests, we can realise the extent of the harm inflicted on mankind by them. It must also be remembered that in most tropical countries the people live only just above starvation level, and that any additional burden will quickly depress them below it. The means by which this anæmia is produced is not clearly understood, but recent work points to the formation of poisonous secretions, toxins, by the worms, which damage both the blood and the blood-forming organs. Bedson has shown that the injection of worm extracts produces acute inflammation of the thyroid, suprarenal capsules, and spleen.

Our armament for offence and defence against these enemies is at present incomplete, but it is becoming more effective. Offensive measures consist in attacking the parasites directly in the bodies of their human hosts, and the main advances have been in the use of oil of Chenopodium against the intestinal worms, Ascaris and Ancylostoma, and the intravenous injection of tartrate of antimony against Bilharzia. The former drug can be used on an enormous scale with great safety and efficiency, and if the inhabitants of a badly infected country can be educated to the point of undergoing treatment *en masse* once a year, a great reduction of disease should result. The second discovery, which we owe to Christopherson, has, at least in theory, entirely changed the future of whole nations. A disease which was previously incurable, and in Egypt, for instance, affects one-half of the people, can now be cured with certainty in a few months. In dealing with ignorant and suspicious native races, however, the rapid adoption of such strange and terrifying methods cannot be expected.

For defensive measures reliance is placed on improvements in sanitation and in the personal cleanliness of the people, advances which will necessarily be slow. No practical means of destroying eggs or larvæ on a large scale in the outer world have yet been discovered. Where an intermediate host exists a reduction of the disease would follow wholesale destruction of, or protection against, the intermediate. In this connection, mosquito destruction has of course already been carried out on a large scale in anti-malaria work in many regions, and it may be extended with the additional object of fighting worm disease. For the destruction of the snails associated with fluke disease periodical drying of canals and irrigated fields has been advocated by Leiper. The knowledge that Clonorchis and Paragonimus are introduced in food should also make the avoidance of these parasites easy.

Three things are above all necessary for the conquest of these plagues: (1) Continued and intensified research into the many points of the intricate life-histories of these parasites and their intermediate hosts which are still obscure; into new methods of destruction, chemical and physical, of both these groups of animals, whether as eggs, larvæ, or adults; and into

new methods of medical treatment for infected man. (2) Systematic instruction and tactful control of the peoples affected. This will be the duty of the medical and teaching professions of the stricken countries. Anyone who has watched the increase of well-taught and capable physicians in such a country as India during the last twenty years will base great hopes on the growth of this influence. (3) And most important, a common and indignant consciousness that these plagues are not inevitable, that by combined effort they can be cast off, and that it is a disgrace to humanity that one-half of its members should be harbouring these loathsome parasites.

The Theory of Relativity in Relation to Scientific Method.[1]

By DR. DOROTHY WRINCH, Fellow of Girton College, Cambridge.

SOME interesting criticisms of the theory of relativity have been advanced recently by M. Paul Painlevé, in two papers in the *Comptes rendus de l'Académie des Sciences de Paris*.[2] M. Painlevé attacks the theory as it at present stands, on grounds which are of general scientific interest. He criticises the expression for ds, the element of length adopted by Einstein,

$$ds^2 = dt^2(1 - a/r) - r^2(d\theta^2 + \sin^2\theta d\phi^2) - dr^2/(1 - a/r),$$

on the ground that it is one of a very large number of forms which satisfy the Einstein conditions. He cites some of the other possible forms for the relation between the length element and the four co-ordinates (r, θ, ϕ, t), and indicates the various consequences which ensue according to the particular form adopted.

At this point we encounter, as M. Painlevé points out, a serious difficulty; but it is a difficulty which is present in all scientific investigations. The botanist plotting on paper the results of experiments which were designed to discover the relation between two variables, x and y, is faced by the same problem when he decides on the method to be adopted in interpolation. For his experiments merely tell him that, whatever the relation between the variables may be, the function connecting them must be such that when $x = x_r$, we also have $y = y_r$, where (x_1, y_1), (x_2, y_2) . . . (x_r, y_r) . . . (x_n, y_n) represent, roughly speaking, the results of his experiments. But the number of his observations is necessarily finite; and it is evident that there are at least as many functions satisfying these conditions as there are points in the mathematical continuum. This difficulty of choosing between a set of functions all of which satisfy the data of the problem presents itself at several critical points of the Einstein theory. It is entirely plain that if science is to be possible, some further principle is required.

THE SIMPLICITY POSTULATE.

In the face of this difficulty, it has been the practice of scientific writers to choose the simplest function available. The question of what constitutes simplicity, or rather the question of when one function is simpler than another, is a difficult one, but in ordinary scientific work, and especially in biology, the term is considered to be well understood. In selecting the simplest alternative, no one, of course, would hold that the other alternatives are impossible. Indeed, the simplicity criterion arranges the various possibilities in serial order. If the first of this set afterwards proves unsuitable, the next one is taken, and so on. Thus, in outline, we may say that the procedure of science is to attach probabilities to the various functions in such a way that the probabilities of functions arranged in order of simplicity decrease rapidly to zero, so that there is little probability of any of the more complicated functions which could be devised being the correct one.

In criticising this procedure from a logical point of view, it will be of no avail to demand, at the outset, a definition of the relation involved in the proposition that one function *is simpler than* another. Common sense uses the notion of simplicity, and we cannot go behind common sense. The business of the logician is to interpret it and relate its various beliefs *inter se*, eliminating when necessary the less fundamental beliefs in favour of those which are held more firmly and the deductions which can be drawn from these beliefs. But this absence of definition makes it important to consider the way in which the simplicity postulate is used in relativity theory. M. Painlevé discusses some of the alternative forms for the length element, to which he sees no objection. He shows that some of them carry with them consequences as to the change in dimensions of a moving body which are mutually inconsistent and in direct contradiction to the Einstein theory. It may therefore be possible to make a choice between some of them by means of data of this kind, and consequently to settle the controversy as to the form of ds, at least to the extent of eliminating those forms which give certain types of change in the dimensions of bodies in motion. M. Painlevé states that he considers some of his forms to be as simple as the form adopted by Einstein. In the absence of a decision being reached by means of further data, the objection of M. Painlevé will fall to the ground only if it is established that the form which Einstein has used for the length element is the simplest one which fits the facts of the external world.

THE VALUE OF COMPREHENSIVENESS.

There is another logical property which enables us to assign a value to rival scientific theories. In choosing between various ways of relating facts *inter se*, we shall evidently prefer theories which group together the largest number of facts under one set of assumptions. Comprehensiveness is, indeed, an important test of the value of a theory, for as the number of facts which are linked together by a theory increases, the theory grows in importance as a

[1] Paper read before the Congress of Philosophy in Paris on December 29, 1921.

[2] "La Mécanique classique et la théorie de la relativité," October 24, 1921; "La Gravitation dans la mécanique de Newton et dans la mécanique d'Einstein," November 14, 1921.

hypothesis, and is of greater value as a guide to the selection of future researches. The recent developments of the theory of relativity due to Profs. Weyl and Eddington are of considerable importance as examples of the value of increasing the range of a theory. Weyl has generalised the geometry used by Einstein in order to produce a function which can conveniently be made to represent the electro-magnetic energy tensor; and Eddington, in accordance with the methodological considerations mentioned above, has suggested still more radical generalisations, with the view of producing, if possible, some function which can be used as an electronic energy tensor. By this we mean a function which contains at least analogues of the main properties of the electron. Towards this very important result Eddington has taken several significant steps, though the physical aspect of this part of the energy of a system, associated with the non-Maxwellian forces, is by no means clear at present. It will obviously be a matter of the greatest importance if it proves possible to cover the electronic phenomena as well as the gravitational and electro-magnetic by a few perfectly definite general assumptions of the same type as those already introduced in relativity theory.

Among the results obtained by Eddington, we may direct attention to the fact that a natural unit of action has made its appearance in terms of which both the energy tensor and the electro-magnetic tensor can be expressed. It appears that this unit of action is 10^{114} times the quantum required in the quantum theory, but the fact that the two energy tensors, which so far have been treated on the lines of world geometry, can be given in terms of the one unit of action may well suggest further developments which may accomplish ultimately the introduction of a tensor to represent the electronic or non-Maxwellian forces.

But let us consider how these advances have been brought about. On Weyl's theory, it is possible that comparisons of length at different times and at different places may yield discordant results according to the route of comparison. In fact, a particular standard of length should apparently be used only at the time and place where it is, for in general, a vector will change its value on describing a circuit. The fundamental apparatus required for measurement is therefore no longer, as in the days before relativity, a unit standard, or indeed, a set of standards, one for each point of space, but a set containing a unit for each point of the fourfold manifold of space and time. Such a system of measures, comprising a fourfold series, is called a "gauge system" in Weyl's theory. In this analytical scheme, however, zero length is unique, and involves no specification of route. But Eddington, with his idea that it may be possible to introduce non-Maxwellian forces into the schema, further generalises this theory by allowing that zero length may not be unique.

In allowing the generalised idea of measurement of Weyl, and of course, still more in countenancing the suggestion of Eddington, we are abandoning a well-established belief in common sense; and indeed, this is the crux of the matter from the point of view of ordinary life. But this is, of course, not the first time that the theory of relativity has asked us to throw away the beliefs of everyday life. These theoretical developments—and, in fact, the whole of relativity theory—have attained so great a degree of complexity that they have far outstripped the powers of deduction possessed by naïve common sense; and this is so in spite of the fact that they, in common with all other branches of physics, started from ordinary common-sense data. The difficulties, from a common-sense point of view, of the theory of relativity, of which we unfortunately hear so much, are due in great measure to the fact that, owing to the extensive analytical development, the postulates from which it starts have no obvious connection with the physical facts which the theory is designed to correlate. Tensors, for example, involve quantities to which no simple physical significance can at present be attached. But even the concept of energy, which has long since taken its place as a physical idea, must at one stage of history have been a difficult idea to the natural philosopher previously limited to concepts such as force. The concept of *action*, as used in the quantum theory at the present time, is scarcely one which the physicist, left to himself, would readily employ, unless it is regarded as being invariably an angular momentum. The Lagrangian idea of *generalised co-ordinates* in dynamics is another case of the same kind. The concepts employed in relativity are at present remote from physical ideas in exactly the same way, though perhaps to a greater extent.

THE THEORY OF RELATIVITY AND COMMON SENSE.

In mathematical theories, not infrequently the logical links between the premises of the problem and the results deduced from them are so many in number that no connection can at first sight be seen between them. In fact, the greater the number of links the more valuable the theory becomes. The purely mathematical background of the theory of relativity consists largely of developments which belong to highly specialised domains; and it is not to be expected that common sense can foresee the results obtainable from specified assumptions which the data of common sense have been found to require. Indeed, we might point out that it is apparent from the mere fact that the tensor theory has been built up into an extensive branch of mathematics (which, of course, happened long before its applications were dreamed of) that the connection between the premises and the results is too complicated to be dealt with without the aid of a specially elaborated technique. It is therefore impolitic to advance common-sense criticisms of the various assumptions as to length which may provisionally be advanced in the theory of relativity with the definite object of effecting further comprehensive correlations of physical facts. For common sense, having provided the jumping-off ground, has a severely restricted part to play in the more technical analysis which the logical development of these assumptions requires; and it is at once the marvel and the allure of the science of our day that mathematics, which is but the child of common sense, has been able, owing to the masterly researches carried on by the pioneers of the nineteenth century, to transform the crude views of her parents into the triumph of modern physics.

Current Topics and Events.

The Rothamsted Experimental Station has taken over the Stackyard field, Woburn, which for many years was held by the Royal Agricultural Society of England, and proposes to continue the experiments on wheat and barley in close association with the work at Rothamsted. Although the Royal Agricultural Society thus gives up its experimental farm, it is gratifying to know that the Society does not intend to break its connection with scientific research; it has set up a Research Fund and a Committee to initiate or receive schemes for investigation, and it proposes to carry out its experiments on the farms of its members. In the first instance four problems will be studied:—(1) The value of ground mineral phosphates, more particularly in the improvement of pasture. (2) The use of various forms of lime on grass and tillage crops. (3) The use of wild white clover, wild red clover, bird's-foot trefoil, etc., in laying down land to grass. (4) The profitable utilisation of whey. We welcome this further evidence of the recognition now widely accorded by farmers to the necessity for further research work in agriculture, and we trust that fruitful means of carrying out such work will be found. There are certain difficulties which should be pointed out. Unless the programme of work and the actual experiments are closely supervised by scientifically trained men, there is great danger that the results may be incomplete, giving much less information than might otherwise be obtained. Without a carefully-drawn-up programme something vitally important is liable to be left undone, or some observation omitted, and in agricultural investigations lost opportunities rarely recur. Moreover, there is a real danger of overlapping; at the present moment there are already two separate bodies studying the effects of mineral phosphates on grassland; fortunately they have co-ordinated their efforts. Neither of these difficulties is insuperable and we have little doubt the Committee will be able to overcome them.

Scarcely any department of scientific research is of such general interest as that which concerns prehistoric man, his development during the Ice Age and the changes then taking place in the conformation of land and sea. Yet, with the exception of the Institute of Human Palæontology in Paris, which was generously endowed by Prince Albert of Monaco, there has been hitherto no special centre for the investigation of this deeply interesting and important period. A public institution for study of the Ice Age has now been established in Vienna in connection with the Natural History Museum of the Austrian Republic, and every effort will be made to investigate the phenomena of the Ice Age on a broad scientific basis. The geographical position of Vienna renders it well adapted for this purpose, since the land structures associated with the glaciation can be studied in the near vicinity and observed in their ancient relations to the environment of pre-historic man. Lower Austria has already furnished a rich store of ancient stone implements and weapons. The Vienna Institute is under the able leadership of Dr. J. Bayer, director of the anthropological and ethnographical collections. Dr. Bayer's papers, in which he demonstrates the existence of no more than two distinct periods of glacial conditions, may be said to have created a new basis for this field of research. Dr. Bayer is assisted by a distinguished group of colleagues, and it is hoped to extend the circle of workers to include those in other countries who are devoting themselves to research on this period. Any such are freely invited to enter into communication with Dr. Bayer at the Natural History Museum, Vienna, who will be pleased to give fuller information as to the present activities of the Institute.

The *Daily News* for March 3 contained an article of three columns by W. B. W. on the constitution of the atom according to the nuclear theory and the disintegration of the atoms of the lighter elements which has been effected recently by Sir E. Rutherford and Dr. Chadwick. The results of their work were recorded in the November issue of the *Philosophical Magazine*, and Sir E. Rutherford gave an account of them in his address to the Chemical Society a few days ago. We welcome the appearance of articles on scientific subjects in the daily press, as they furnish one of the best means of keeping the public acquainted with the interesting work which is being done. There is a tendency, however, in such articles to represent each development as a sensational one, and the public gets the impression that the foundations of science are overturned every month or two. It is not in the interests of science that such a false impression should be produced, and we see no reason why a sensational turn should be given to an article on a scientific subject while an archæological discovery is allowed to speak for itself. There is room in the daily press for a regular series of articles on scientific subjects to maintain the tradition established by Lord Rayleigh and Sir Ray Lankester a dozen years ago.

The British Non-Ferrous Metals Research Association has just issued its second annual report. During the past year the membership of the Association has increased very largely, the principal trade associations having joined it. The programme of research work which has been undertaken is very extensive and has been divided among various university and national laboratories and individual firms having the necessary equipment. The influence of impurities on copper, the polishing of metals, atmospheric corrosion and methods of joining metals, are among the subjects now being investigated, and considerable progress has been made in dealing with some of them. At the second annual meeting, held in Birmingham on March 3, and preceded by a luncheon, the progress of the Association was surveyed. Vice-Admiral Sir George Goodwin, Dr. Rosenhain, Sir Henry Fowler, and Sir Frank Heath were among the speakers, who emphasised the importance of co-operative research of this kind to the metal industry. The policy of the Association is not confined to the solution of imme-

diate works problems, but involves a thorough study of the fundamental properties of the principal non-ferrous metals and alloys. In the adoption of such a far-sighted policy it is certain that the Association has taken a wise step, since the more important advances in industrial progress are usually the result of research on fundamental problems rather than on the overcoming of minor difficulties.

AN explanatory statement on the Navy Estimates has been issued by the First Lord of the Admiralty as a White Paper (Cmd. 1603). In a detailed account of the reductions in the various votes which go to make up the estimates, Lord Lee announces that the expenditure on education and scientific services in the Navy is to be reduced by 122,000*l*. The Admiralty is of opinion that a more drastic reduction would be undesirable at a time when it is hoped that the Navy will make up in quality of *personnel* and superiority of technique for the lead that has been surrendered in respect of *matériel*. The importance, and the previous inadequacy, of scientific research was clearly demonstrated during the War, and the Admiralty is convinced that the measures which it has taken are not more than sufficient to maintain research and experiment on a sound though economical basis.

THE Summer-Time Bill was read for a second time in the House of Lords on March 9. The measure provides that summer-time shall begin on the night of the last Saturday in March (unless the next day be Easter Sunday), and come to an end on the first Saturday in October. This year, therefore, summer-time will come into force at 2 o'clock G.M.T. on the morning of Sunday, March 26, and will continue until 2 o'clock G.M.T. on the morning of October 8. The French Chamber of Deputies on March 9 voted against the adoption of summer-time, but afterwards accepted an amendment to introduce it this year on account of arrangements already made with Great Britain and Belgium. The Senate agreed on March 14 to adopt this course, but prefects are to have local option of following the old time.

PROF. M. PLANCK has been elected a foreign member of the Swedish Academy of Sciences, Stockholm.

SIR ERNEST RUTHERFORD, Cavendish professor of experimental physics in the University of Cambridge, has accepted the nomination of the council of the British Association to be president for the annual meeting to be held at Liverpool next year.

ON Tuesday next, March 28, at three o'clock, Dr. J. W. Evans will begin a course of two lectures at the Royal Institution on "Earth Movements." The Friday evening discourse on April 7 will be delivered by Sir Ernest Rutherford on "The Evolution of the Elements."

WE record with deep regret the death on March 19, at sixty-one years of age, of Dr. G. B. Mathews, formerly professor of mathematics, University College of North Wales, and for many years a much esteemed contributor of reviews and articles on mathematical subjects to our columns.

DR. O. STAPF, who has been keeper of the Herbarium and Library at the Royal Botanic Gardens, Kew, since 1908, retired on February 28, having reached the age limit. He is succeeded as keeper by Mr. A. D. Cotton, formerly a member of the Herbarium staff and lately mycologist to the Ministry of Agriculture and Fisheries.

THE following were elected fellows of the Royal Society of Edinburgh at the Ordinary Meeting on March 6:—Mr. C. L. Abernethy, Prof. G. Barger, Sir Dugald Clerk, Dr. F. A. E. Crew, Dr. W. O. Greenwood, Mr. W. A. Guthrie, Prof. R. K. Hannay, Prof. E. Hindle, Dr. C. F. Juritz, Prof. J. C. Meakins, Mr. M. Macgregor, Dr. Bijali Behari Sarkar, Prof. H. W. Turnbull, Dr. J. Walker, Mr. J. Wilson, Mr. J. M. Wordie.

THE Anglo-Swedish Society has awarded its travelling scholarships for this year to Miss Joan Evans, librarian at St. Hugh's College, Oxford, to enable her to study the collections of early gold work in the Swedish museums; and to Mr. W. N. Edwards, of the Geological Department of the British Museum, to enable him to study the fossil plants in the museums of Stockholm, Upsala, and Lund.

A COMMITTEE has been appointed by the Minister of Health to advise on the preliminary steps to be taken in regard to the site and planning of the School of Hygiene, in London, towards the building and equipment of which the Rockefeller Foundation recently promised a gift of two million dollars. The members of the Committee are:—Sir Arthur Robinson (chairman), Sir Frank Baines, Dr. H. H. Dale, Sir Walter Fletcher, Sir William Leishman, Sir George Newman, Sir Cooper Perry, Sir Herbert J. Read, and Dr. H. Meredith Richards (secretary).

AT the annual general meeting of the Ray Society on March 9 the following officers were re-elected:—*President*, Prof. W. C. McIntosh; *Treasurer*, Sir Sidney F. Harmer; *Secretary*, Dr. W. T. Calman. Dr. B. Daydon Jackson was elected a vice-president. and Mr. E. T. Browne, Prof. E. B. Poulton, and Dr. A. Smith Woodward were elected new members of council. In the report of the council regret was expressed that it had not yet been possible to issue the first part of the fourth volume of Prof. McIntosh's "British Marine Annelids," due to subscribers for 1920, owing to delay in the execution of the coloured plates. It is hoped to publish it in the near future, and the second part of the volume, which will complete the work, will be taken in hand at once and will form the issue to subscribers for 1921.

AT the meeting of the Royal Geographical Society on March 20, the president announced that H.M. the King has approved the award of the Royal Medals as follows:—*The Founder's Medal* to Lieut.-Colonel C. K. Howard-Bury for his distinguished services in command of the Mount Everest Expedition of 1921; *The Patron's Medal* to Mr. Ernest de K. Leffingwell for his Surveys and investigations on the coast of northern Alaska. The Council has awarded *The Victoria Medal* to Mr. J. F. Baddeley for his great work on the Historical Geography of Central Asia; *The Murchison Grant* to Mr. Charles Camsell

for his Explorations and Surveys in northern Canada; *The Back Grant* to Khan Bahadur Sher Jang for his Surveys on the Indian Frontier and in adjacent countries; *The Cuthbert Peek Grant* to Mr. F. H. Melland for his Explorations in Northern Rhodesia; and *The Gill Memorial* to Mr. A. A. R. Boyce for his triangulations in the Sudan.

AT the Annual General Meeting of the Optical Society, held on February 9, the following officers and members of council were elected:—*President*: Sir Frank Dyson. *Vice-Presidents*: Prof. F. J. Cheshire, Mr. T. Smith, Mr. R. S. Whipple. *Treasurer*: Maj. E. O. Henrici. *Secretaries*: (*a*) *Business Secretary*—Prof. Alan Pollard, Imperial College, South Kensington. (*b*) *Papers Secretary*—F. F. S. Bryson, Glass Research Association, 50 Bedford Square, W.C.1. *Librarian*: Mr. J. H. Sutcliffe. *Editor of Transactions*: Dr. J. S. Anderson. *Council*: Dr. J. S. Anderson, Instr.-Comdr. T. Y. Baker, Mr. L. Booth, Mr. R. W. Cheshire, Dr. R. S. Clay, Dr. J. W. French, Mr. W. Gamble, Mrs. C. H. Griffiths, Mr. J. Guild, Mr. L. C. Martin, Dr. R. Mullineux Walmsley, Prof. A. W. Porter, Mr. J. Rheinberg, Mr. A. Whitwell. Prof. A. A. Michelson, of the University of Chicago, and Dr. M. von Rohr, of Messrs. Carl Zeiss, Jena, were elected Honorary Fellows of the Society.

THE Annual Report of the Delegates for Forestry at Oxford shows a large number of students in this subject during 1921, no less than 52 (including 2 ladies) having been awarded the Diploma in Forestry. Of these 45 obtained Government appointments. Practical work was carried out by the students in the Crown woods of Dean, Tintern, and High Meadow and in Bagley wood near Oxford. The list of published papers by members of the staff shows research mainly in insect and fungus pests.

THE annual report of Livingstone College for the year 1920–21 has recently been issued. The College is doing excellent work in training missionaries in the elements of medicine, and 36 students entered for varying periods during the session. There is now an accumulated deficit of 1021*l*. on the working of the College, and subscriptions are earnestly asked for, There is great need for bursaries of about 50*l*., which could be offered to missionary societies or to suitable candidates to enable students to enter for the full course of the College.

IN the January number of *The Fight against Disease*, published by the Research Defence Society, an account is given of the Nottingham outbreak of smallpox down to November 21 last. The number of cases was 81, none of which proved fatal. Of these, 65 occurred in unvaccinated persons, and in none of the others had vaccination been performed within thirty-three years of the attack. All members of the Hospital and Health Department staffs in contact with the smallpox cases—some 120-130 in number—were recently vaccinated, and no member of these staffs contracted the disease.

MESSRS. BURROUGHS WELLCOME AND CO., of Snow Hill Buildings, E.C.1, have just issued another booklet, which may be had free on application. "The Right Way in Photography" gives instructions that reduce the process of taking photographs to a mere matter of routine. The booklet will prove of interest and use to those who do not need elementary instruction by reason of the various tables it contains, showing the times of development required at various temperatures, using various tanks, and various strengths of solutions; and a very long list of plates, classified according to the multiplier of the time indicated that is necessary for each.

THE *Journal des Débats* states that during a visit to the National Porcelain Factory at Sèvres the President of the Republic and Mme. Millerand were shown the operation of an experimental oil-fired porcelain kiln. Hitherto the kilns have been fired by wood (oak for the small and birch for the large furnaces), but it is pointed out that the Copenhagen factory has, for some time past, been using oil-fuel, which affords better control and necessitates only one man per kiln instead of two. The results of the experiments at Sèvres have been fully satisfactory, and although fuel oil is costly in France at present, it is thought that its application to pottery and porcelain firing may sooner or later revolutionise the ceramic industry.

THE Spanish NATURE (*Iberica*) continues to make rapid strides, and the recent double number (January 21-28) is a remarkable production in every way, many of the advertisements being excellently produced in colours. Among the contents may be mentioned a full description, well illustrated, of the new commercial university at Deusto, which is laid out and equipped on modern lines. Another interesting description is that of the largest quicksilver minefield in the world at Almadén, in the province of Ciudad Real, which comprises to-day twelve separate mines having an annual output of some 20,000 bottles of mercury of 11·5 kilos each. There are notes on the New Metropolitan Railway in Madrid; an interesting article, illustrated in colours, on geometrical anaglyphs and stereoscopic vision; a brief historical account of developments in locomotive design; some notes on the progress of railway electrification in Italy; and the usual notes from foreign sources.

WE have received a circular announcing the publication in Italy of an Encyclopaedia of Science and Arts. The work, which will be entirely new and contain twice the number of articles of the present edition of the "Encyclopaedia Britannica," is to be under the direction of Prof. Giorgio Giuseppe Ravasini da Buie d'Istria, and will be prepared in collaboration with the foremost scientific authorities in Italy. Articles and information from private individuals will be welcomed and paid for, according to their value and number, in money or in one or more subscriptions to the complete work. The encyclopaedia will be copiously illustrated by ordinary and coloured plates, maps, plans, etc. The publication of the work is being undertaken by the publishing house of the Accademia "Scienze ed Arte," and all inquiries regarding subscriptions or contributions should be addressed to Accademia "Scienze ed Arte," Sezione Enciclopedia, Via Ugo Foscolo 2, Trieste (Italy).

Our Astronomical Column.

THE APPROACHING OPPOSITION OF MARS.—Mars will be closer to the earth next June than it has been since 1909; the opposition of 1924 will, however, be still closer, the distance being then almost the absolute minimum. The high south declination next June of 26°, making its meridian altitude at Greenwich only 12°, will prevent any useful work from being done in this country. The nearest approach to the earth, 0·45 astronomical units, is on June 18; a week later the autumnal equinox of the northern hemisphere will occur, so that both polar caps should be visible. The earth will remain to the north of the Martian equator till mid-September.

PLANETARY OBSERVATIONS AT SÉTIF.—M. Jarry-Desloges established an Observatory at Sétif, N. Africa, specially for planetary and lunar observations, and he has lately published a large illustrated volume containing studies of the moon and all the planets. Mercury was found a fairly easy object by day, the spots being nearly as well-defined as those of Mars. The results confirm those of Schiaparelli and Lowell, making the period of rotation 88 days, equal to that of revolution. Other observers have concluded that the low albedo, and the absence of an external ring of light when the planet is entering on the sun in transit, negative the idea of an appreciable atmosphere; this volume, however, supports the presence of occasional mist or cloud veiling some of the markings and altering their aspect. It is pointed out that the light and heat received from the sun at perihelion and aphelion are in the ratio of 9 to 4, which would make much difference in the precipitation or dissipation of cloud. Most of the markings are broad, curved, dusky streaks, some 60° in length; there are a few larger spots. The colour of the disc was generally rosy.

Drawings of Uranus show markings not unlike those of Saturn; there is a bright equatorial belt, and fairly bright belts in each temperate zone, with darker regions between them and round the poles. The markings are much inclined and curved, but exact measures are not given. It was noted that the direction of the belts changed during the night, showing that they cannot be quite parallel to the equator. Dark belts were also seen on Neptune, making in 1914 an angle of some 40° with the east-west line, and slightly curved. Neptune's satellite Triton was generally easier to see than Mimas; two fainter stars were seen on February 15, 1914, between Triton and Neptune.

There are also interesting drawings of Saturn, showing notches in the outline of the Cassini division, and in that of the crêpe ring. The markings seen on Venus were so vague and difficult that no deduction was made of the rotation period.

STARS OF CLASS A IN THE SOLAR CLUSTER.—Both Sir J. Herschel and Dr. Gould noticed a zone of bright stars, the medial line of which makes a small angle with the Milky Way. Later on, the local cluster of B stars studied by Prof. Charlier was found to mark out nearly the same great circle. Dr. Harlow Shapley and Miss Annie J. Cannon, in Harvard Circular No. 229, describe the distribution of the stars of spectral type B8, B9, A0, A2, A3, of magnitude 6·5 or brighter. The stars, 2450 in number, are plotted in galactic co-ordinates on an equal-area projection. The median galactic latitudes of the stars in each 10° of longitude are then found and marked with crosses. The resulting smoothed curve shows maxima and minima as follows: long. 50°, lat. +5°; long. 195°, lat. −6°, long. 300°, lat. +7°; long. 335°, lat. −4°. These results are considered to confirm the existence of the local cluster, but also to show the presence of some disturbing factor, possibly a separate cluster about the region of Corona Austrina. It is intended to pursue the investigation with stars of "later" spectral types, for which spectroscopic parallaxes can be found.

THE PERTH SECTION OF THE ASTROGRAPHIC CATALOGUE.—The publication of Zone −35° of this catalogue by Mr. Curlewis was noticed in this column a few weeks ago. Zone −33° has followed it after a very short interval, the arrangement being in all respects similar. It appears in 4 parts, each containing 6 hours of R.A.; they contain respectively 7393, 25,882, 21,163, and 16,365 stars. The variation in star-density with galactic latitude is again very striking; it will be remembered that the south galactic pole is in Decl. −29°, so that these zones embrace practically all galactic latitudes. The ratios of the numbers of stars in each volume to those given in the same areas in the Cape Durchmusterung are 3·5, 5·7, 5·7, 4·6 respectively. Actually the extreme ratios are 2 in poor fields near the galactic pole and 8 in rich galactic fields.

The places of the reference stars have been taken from the recent Perth Catalogue; the tables for reduction from rectangular co-ordinates are in the same form as those in the Oxford Astrographic Catalogue.

THE LIGHT-CURVE OF NOVA CYGNI, 1920.—An exhaustive discussion both of the light-curve and of the colour variation of this Nova is given in Publications of Urania Observatory, Copenhagen, 2nd Series, No. 3. The Nova was of special interest from its comparatively slow rise to maximum and its early visual detection, which enabled observations to be made on the up-slope of the curve: two photographs taken before discovery, at Kvistaber, by Mr. Tamm, and at Harvard, fully confirm the leisurely nature of the increase of light. The apex of the curve, at mag. 1·8, is very sharp. The fall of light was at first very rapid, amounting to 2½ mags. in ten days; it then became slower but still uniform for 3 months. Here it began to be oscillatory; after another 3 months the oscillations grew larger and the diminution of light slower; in the year ending 1921 Sept. the mean magnitude fell from about 8·6 to 9·7.

The colour determinations are much less consistent than those of magnitude, but they suffice to indicate that at discovery the colour was less than 2, while three months later it rose to 6 or 7, on a scale extending from 0 (white) to 10 (red). The colour at maximum was yellow. A table of photographic magnitudes for the first six months is also included in this publication. This indicates a fall of light from magnitude 2·12 (at maximum) to magnitude 10; a comparison of this table with that giving the visual magnitudes fails to indicate the rapid increase in redness after maximum which the observers noted.

SLIDES OF PHOTOGRAPHS TAKEN AT YERKES OBSERVATORY.—The beauty of the slides taken with the 40-inch refractor at Yerkes Observatory is well known, and a selected list of a hundred slides is now being offered for sale. The price asked is 62½ dollars in addition to carriage; 75 cents is charged for single slides, and double this amount for coloured slides.

Research Items.

THE BULL ACROBATS AT KNOSSUS.—In the Journal of Hellenic Studies (vol. xli. part 2) Sir Arthur Evans describes a remarkable bronze group from Knossus in Crete, representing an acrobat jumping over a galloping bull in the arena. The high action and skilful modelling of this animal are altogether unique among the relics of Minoan metallurgic craft, and for vigour and beauty this far exceeds two representations of such feats discovered by Schliemann and others. The full stretch of the bull's legs conforms to what is known as the "flying gallop" scheme, and the small figure of the acrobat, apart from the conventional attenuation of the waist, is finely executed, and even his features, though abnormally diminutive and incompletely brought out by the casting, with the sinewy development of form, due to athletic training, are well indicated. In other examples of feats of this kind the performer is usually a girl, but there can be no doubt that this figure is a male. In a representation of the same class on the bull *rhyton* it is clear that at the epoch to which it belongs, that is, about 2000 B.C., the long-horned Urus breed of cattle had been already introduced into Crete. The earlier indigenous variety, a form of shorthorn, *Bos Creticus* of Boyd Dawkins, was not well adapted for such a form of sport.

THE PALÆOLITHIC AGE IN INDIA.—The discovery of stone implements in India began with an implement found by Mr. Le Mesurier in 1861, and since that time many specimens have been found. But only two cases are known in India where stone implements have been found associated with the remains of extinct animals, in the Nerbudda and Godavari valleys, and further evidence of their occurrence in strata, the date of which can be established, is much to be desired. In the March issue of *Man* Mr. T. H. Vines reports the discovery of flint workshops in hills overhanging the North Indus valley. These consist of cores and broken chips, with a yellowish-brown fabrication and lustre. In the ravines of these hills flint knives and other tools of a white or whitish colour are found in considerable numbers. Mr. Vines suggests that the strata in which these implements are found correspond with the area in Egypt where implements of the same type have been discovered by Prof. Seligman (Journal Royal Anthropological Institute, vol. li. p. 115). The area to which Mr. Vines refers well deserves examination, as its geological character may form the basis of fixing an approximate age for manufacture of these implements.

MAN IN THE PACIFIC.—At the meeting of the British Association held in Australia in 1914 the desirability of fuller knowledge of the Pacific was advocated. In response to this appeal the Legislature of Hawaii appropriated funds to be used by the Pan-Pacific Union in defraying the cost of a Pan-Pacific Commercial and Educational Congress to be held at Honolulu in 1920. The Bernice P. Bishop Museum has now issued, as No. 7, Part I., of its publications, a full report of the Proceedings of the Congress, which are of peculiar interest. The papers now published are devoted to the question of Race Relations. In a valuable paper on "Man in the Pacific," Dr. Clark Wissler remarked on the need for such investigations as "the old Polynesian is passing the last mile-post of his career." "First, we need a geological survey of the several island groups; for the backbone of man's chronology is geological chronology. Further, we need data upon the fauna and flora of the respective islands. It is the realisation of this inter-relation of problems that underlies the conception of this congress and is its only excuse for being. You tell us the history—a relative chronology—of such plants as taro, bread-fruit, the paper mulberry, etc., and the story of such mammals as the pig and dog, and of the chicken, in the islands of the Pacific, and we will soon fill in the gaps in the chronological scheme for the Polynesians."

THE AMERICAN INDIANS' KNOWLEDGE OF THE MASTODON.—In *Natural History*, the Journal of the American Museum of Natural History (vol. xxi. No. 6), Mr. J. L. B. Taylor, under the heading: "Did the Indian know the Mastodon?" describes a bone bearing an incised elephant-like figure, found in the Jacobs Cavern, Ozark Country, near Pineville, Missouri. Dr. Clark Wissler, who has examined this bone, regards the work as what might have been expected from the hand of an American native; three attempts to represent living forms, apparently by the same artist, are identified—"Two have the distinctive lines of elk and deer, while the lines of the third characterise elephant kind, and this favours the interpretation that an elephant, mastodon, or mammoth was intended. At once the objection will be raised that the bone is recent. Though the mastodon and the mammoth are characteristic of Pleistocene time, it is not known when they became extinct: for all that is known to the contrary these great mammals may have held out within 3000 years ago. . . . No one in authority seems now prepared to deny that man was in America 3000 years ago." Dr. Wissler regards this discovery in Jacobs Cavern as of great importance; "it is to be hoped that at last we are on the trail of early man in America."

BEHAVIOUR OF STOMATA.—In a significant paper on the behaviour of stomata (Carnegie Institution of Washington, Publ. No. 314) Mr. J. V. G. Loftfield has made important additions to our knowledge of the action of stomata in relation to the environmental and physiological conditions of the plant. He used the method of fixing strips of the epidermis in alcohol, supplemented by direct microscopic observation of the living, attached leaf. Many of the observations were continued every hour throughout the day and night, microphotographs showing the condition of the stomata on the upper and lower epidermis of leaves being ingeniously arranged in circles for comparison with the corresponding continuous circular records of light, temperature and humidity. Many plants were studied under different climatic conditions, and it was found that while illumination affects the action of stomata, as has long been known, yet weather conditions also control the size of the openings, and with varying water supply the stomata may change their behaviour from day to day. Some of the movements were quite rapid, from fully open to closed in less than an hour. Low morning temperatures caused the stomata to open very gradually, and even moonlight affected the size of aperture. The great majority of the stomata on a leaf behaved alike, but about 2 per cent. were functionless and 3 per cent. superfunctional, opening to twice the normal maximum. The plants studied fell into three groups. In cereals the stomata are very sensitive and never open at night. In another group, as conditions become less favourable the stomata open at night and close for a time about midday. In the potato and other plants the stomata are normally open at night and close only under conditions of high evaporation or low water-content. Light induces the opening of stomata by causing the conversion of starch in the guard-cells into sugar and so increasing their osmotic pressure. This work

shows that stomata are regulatory in their action, a fact on which earlier investigations had thrown some doubt. It indicates that there are considerable fluctuations in the water-content of a normal leaf, and that the regulation of water-loss by the stomata is very effective when they are nearly closed.

Silk Weavers and their Output.—In Report No. 17 of the Industrial Fatigue Research Board, Mr. P. M. Elton analyses the differences in the output of individual silk weavers. Silk weaving is a highly skilled occupation, and it takes at least two years to teach a girl to weave quickly and well. Hence it is very important that unsuitable girls should not waste their own time, and that of their employers, in undergoing training. Training has often been faulty in the past, and in consequence bad methods of work are acquired which are never eradicated. So important is the human factor for success in silk-weaving that the quickest operatives consistently produce about twice as great an output as the slowest. Mr. Elton analyses the causes of these wide variations in detail, and his report should be of great value to those engaged in teaching young weavers. A weaver has to have good eyesight, be dexterous with both hands (for in weaving both hands are simultaneously employed on very different operations), and have a delicate sense of touch. Mr. Elton has not endeavoured to determine the most suitable tests for would-be apprentices to the weaving industry, but there should be no difficulty in the choice of some of the necessary tests. A thoroughly adequate selection can only be made gradually, after much experiment, but few more fertile fields for the application of the principles of "vocational selection" [can offer themselves than that of weaving.

Electrical Precipitation in Industry.—In the Journal of the Society of Chemical Industry for February 15, Dr. H. J. Bush gives an account of the industrial applications of electrical precipitation. In 1884–86 Sir Oliver Lodge carried out experiments on the electrical deposition of fog and smoke, and patents were taken out in England and other countries during those years. In 1884 Dr. Karl Moeller, in Germany, obtained an independent patent. In 1906, Dr. F. G. Cottrell, Director of the United States Bureau of Mines, then professor of physical chemistry in the University of California, repeated Lodge's experiments in connection with the removal of acid mists, and in his hands the process has been largely developed. During the war a very large Cottrell plant was in operation at the Queen's Ferry works, and an installation was designed by the Lodge Fume Co. for cleaning blast-furnace gases. Dr. Bush gives an account of these and other plants. The principle is very simple. An insulated wire hangs inside a metal tube, both being connected with a high voltage transformer, or special electrodes are hung between metal plates. The fume passes through the apparatus, and the electric discharge brings about its precipitation. The mechanism of the process appears to be somewhat obscure, and the account given by Dr. Bush is very empirical. Further scientific work will probably throw light on this interesting process. Electrical precipitation has a large field of possible applications.

Separation of Isotopes of Mercury.—In the January number of the Journal of the American Chemical Society, Prof. W. D. Harkins and R. S. Mulliken describe the experimental separation of mercury into isotopic fractions by evaporation in a vacuum. A difference in density of 133 parts in a million was obtained. A theoretical discussion of the resolution of isotopic mixtures by diffusion and similar processes is given, and equations are obtained showing the rate of separation to be expected in such processes. This work supplements previous results by other workers given in Nature, vol. cvi. p. 144; vol. cviii. p. 209.

Ammonia Oxidation.—During the war the oxidation of ammonia was studied in England with a view to its application in the State factory for the fixation of nitrogen. Although the other parts of the chain of operations leading from atmospheric nitrogen to nitric acid never materialised, the process of ammonia oxidation was brought to the stage of technical application, and was taken up by different firms in connection with the supply of oxides of nitrogen to sulphuric acid chamber plants. In the Journal of the Society of Chemical Industry for February 28, Messrs. C. S. Imison and W. Russell, of the United Alkali Company, give a very interesting and detailed account of the improved process now in operation. They remark that, so far as their experience goes, there is little difference in cost between this and the old retort processes for making strong nitric acid with nitre and ammonia at present prices, but if the published estimates for the cost of synthetic ammonia are realised in this country, the balance will turn strongly in favour of the oxidation process. They also point out that the oxidation process is an integral part of the process for the fixation of atmospheric nitrogen, which, in conjunction with a fixation process for ammonia, would render this country independent of overseas supplies of nitre in the event of another war. It seems strange that, among so much legislation for "key industries," the absolutely vital problem of nitrogen fixation has never been mentioned.

Radium Mining.—In a circular issued by the Colorado School of Mines, entitled "A World Storehouse of Rare Metals, Radium, Uranium and Vanadium, the Paradox Field of South-western Colorado," interesting information is given of the present conditions prevailing in what is undoubtedly the richest radium region of the world. The ore mined is carnotite, a potassium uranyl vanadate of the composition $K_2O,2UO_3,V_2O_5,3H_2O$, occurring in sandstone in the San Miguel, Dolores, Mesa, and Montrose counties of S.W. Colorado. The ore, as mined, contains usually from 1·4 to 1·8 per cent. of uranium oxide, averaging some 4 milligrams of radium to the ton and 4 or 5 per cent. of vanadium oxide. Of a total of 52,000 tons produced in the U.S.A., Colorado has produced 48,700 tons, of which 38,000 tons were mined by one company, the Standard Chemical Co. of Pittsburgh. Smaller quantities have been produced also in Wyoming and Utah. The ore is prospected for by diamond drilling to a depth of some 40 feet and mined by inclined shafts and gravity tunnels. The deposits occur in sedimentary rocks, and so far are confined practically to what is known as the M'Elmo formation. Though easily recognised as outcrops, the deposits of carnotite are exceedingly variable and obey no law of deposition. They are often associated with fossil wood as "logs," in which the mineral has replaced the trunks of trees embedded in the rocks. It is concentrated *in situ*, if of less than 2 per cent. U_3O_8 content, and furnishes not only the largest present source of radium but also an important source of the vanadium, now so largely employed in the manufacture of special steels. The Colorado School of Mines maintains a special well-equipped radioactivity laboratory for the estimation and evaluation of these ores.

Growth and Sex-Factors of Racial Character.

AT a meeting of the Royal Anthropological Institute held on February 28, Dr. W. H. R. Rivers, president, in the chair, Miss R. M. Fleming read a paper on "Growth and Sex-Factors in Racial Analysis." Her results were based on a large number of measurements made, for the most part, in Wales, the measurements in the case of the children having been repeated at regular intervals.

Miss Fleming said periodic re-measurement of children during growth shows that—

1. Boys and girls have different growth cycles as regards features used in racial analysis;
2. Head breadth commonly increases more than head length, so the cephalic index usually rises during growth. Cephalic index of girls rises most quickly between the third and eighth years, while in boys it does so especially after the tenth year. Changes of one unit in one year were general, and larger changes frequent;
3. The frequent darkening of hair and eye seen in both sexes shows the same difference of period, and also confirms the results of Pryor's work on ossification of wrist bones;
4. There are clear correlations between facts of physical growth and mental development, and these correlations should influence educational methods.

British women show more development of pigment, brachycephaly, and prognathism than do men. Sixty per cent. of any normal sample of men have cephalic index 75-79; nearly the same proportion of women have indexes 77-81. Men outnumber women under 75 and women enormously outnumber men over 84. Men have the glabella stronger and women the occiput larger in most cases, but this does not account for the difference, which is one of growth.

Among the types noted are the following:

a. Dark-haired, dark-eyed women, head length 181-193, head breadth 143-154, cephalic index 77-81, calvarium rather low, prognathism slight or absent, forehead usually full, occipital prominence marked and low.

About 50 per cent. of the sample of women studied possessed most of these characters, and they were very marked among the Welsh people. This group corresponds with Fleure's group of men of indexes 75-79, dark colouring, but the women show greater heterogeneity;

b. Dark-haired, dark-eyed women, head length 187-199, head breadth 137-148, cephalic index 76 or less. Bony development more marked and head height greater than in "*a*," forehead more often receding, prognathism often marked. A remote hill country pedigree is common for this type, and one often finds flattened nostrils, deep-set eyes, hair low on the forehead. A few are darker in youth than later on. Intellectual distinction is frequent.

c. Light-haired, light-eyed women, head length 180-192, head breadth 145-153, but measurements a little lower in general than in "*a*" and "*b*." Prognathism absent or very slight, bizygomatic breadth small, face long, calvarium finely arched, forehead often retreats, bones strong, stature averages 3 inches more than in "*a*" and "*b*." Type less frequent than "*a*" and "*b*" among purely Welsh peoples.

d. Fair longheads, very narrow, breadth about 132-137, low foreheads, slight build, low vitality.

It is not suggested that this group has any historical or racial significance. The fair and dark broadheads have not yet been examined in sufficient numbers to warrant discussion, especially as the analysis of male broadheads has not yet proceeded very far.

A discussion followed the reading of the paper, in the course of which Prof. Parsons pointed out that Miss Fleming's work corroborated the results which he himself had obtained both as regards the conclusion that the breadth of head of women was greater than that of men in the corresponding series, and that women were darker. Prof. Fleure said that Miss Fleming's work represented a real advance in the attempt to provide a sure foundation for physical anthropology, while it showed that the conclusions of Prof. Boas as to the change in head form of immigrants in the United States were unsound. Several speakers emphasised the importance of Miss Fleming's results for the educationist in connection with the classification and grading of children of both sexes.

Mortality Tables.

THE Privy Council Medical Research Council has published as the sixtieth of its Special Report Series a valuable memoir by Dr. Brownlee, the director of statistics of the council, on the use of death-rates as a measure of hygienic conditions (H.M. Stationery Office, 1922, 80 pp., 3s. net). Some of the methods employed for that purpose are likened by Dr. Brownlee to those of the tailors of Laputa. He divides the subject into two parts: (1) death-rates in general and (2) mathematical treatment, and illustrates it by 30 tables and 16 diagrams. On special points he has had recourse to Sir Alfred Watson, whose great experience in the construction of mortality tables must have been valuable.

The crude death-rate on a large population requires adjustment and correction. When applied to sections of the population, as to those dwelling in certain districts or those engaged in specified occupations, the liability to error is greatly increased. The method by which these are corrected is called "standardising."

For the purpose of life-tables the death-rate is taken to signify the ratio of the number of deaths of persons above any defined age, to the number living above that age, in a stationary population. They show some disadvantage in using standardised death-rates. So far back as 1875 the late Dr. Wm. Farr was sensible of this difficulty, and devised a method for meeting it, which Dr. Brownlee considers to present great advantages. Prof. Karl Pearson held that causes of death might be specially grouped to correspond with periods of life. Dr. Brownlee gives a re-drawing of Prof. Pearson's diagram (Trans. Roy. Soc., 1894) representing the curves for infantile mortality and the mortality of childhood, youth, middle age, and old age respectively.

The tables of Dr. Farr, based on returns from 1861 to 1870, provide information as to causes of death for selected districts according to sex and age. Later tables calculated by Mr. George King, the eminent actuary, show that the same conditions still hold. Dr. Brownlee supplies a table giving a summary of observations in various districts from 1838 to 1912, and comparing the standardised death-rates with the life-table rates for each observation. Though a life-table death-rate is the criterion of ultimate

importance, he arrives at the conclusion that there is a direct relation between it and a standardised death-rate. This is confirmed by some calculations made by Mr. Finch. Applying the death-rates at each quinquennial period of age to a standard population adjusted so as to be in arithmetical progression, for which purpose the mean population for the decade 1891–1900 was adopted, the errors appeared to be remarkably small.

Dr. Farr held that density of population and death-rate were closely connected. The difficulty has arisen in applying the two to London, which possesses a greater absolute healthiness than its density would suggest. May we not infer that this is partly due to good management and sanitary conditions?

It is less easy to get trustworthy generalisations where the numbers are small. Dr. Brownlee supplies a valuable series of tables of the numbers living and the expectation of life in selected healthy and unhealthy districts for use in calculating the death-rate from various diseases. He infers from them that persons who died at the age of fifty-one years in the average environment might have had a life of seven years longer in the mean had they lived in the country.

Proceeding to the consideration of the effect of particular diseases, Dr. Brownlee takes (1) Phthisis. The age at which phthisis causes death is shown to vary greatly in different districts. (2) Sarcoma and cancer. Here for an equal number of deaths the age at death is shown to be later where the conditions are healthier. (3) Valvular disease of the heart. This seems to behave in much the same way. (4) Diabetes. Here, whether a person lives in a rural district or in a county borough, the commonest age at death is the same. (5) Nephritis. This is much less prevalent in rural than in city districts. (6) Pneumonia. Deaths from this are least in rural districts. Care has to be taken in dealing with the three elements of the problem, age, environment, and disease.

In pt. 2, relating to the mathematical treatment of the subject, Dr. Brownlee seeks to give directions for calculating life-table data by short and easy methods. Those desirous of making inquiry into health conditions will, however, have to bear in mind the many pitfalls that they may meet in so delicate an investigation. Dr. Brownlee's authoritative and suggestive report will enable them to avoid the danger of hasty conclusions.

Population Maps.

THE possibilities of the quantitative representation of geographical data as regards population distribution are discussed in some detail by the originator of a new method, Mr. S. de Geer, in the *Geographical Review* for January. Mr. de Geer has already applied the method in the recently published atlas of the distribution of population in Sweden. In the ordinary map the position and size of cities and smaller centres are shown by dots. A further development is to show relative density by shading or colour-tints of varying depths. The chief defect of such maps is that, as a rule, they show only the average over large areas such as counties or parishes.

The dot method of Mr. de Geer offers the possibility of combining a clear representation of situation and a mass of population within wide limits. The dot represents a unit of population of fixed value; the larger the scale of the map the smaller the unit. On a scale of 1 : 100,000 a dot might represent ten persons; on one of 1 : 80,000,000 perhaps a million persons. The unit-dots are considered as small spheres, and should be shaded as such, but this involves expense and difficulties in printing; they are therefore drawn solid black. Small towns are shown by groups of dots arranged in squares, rectangles, or other figures corresponding roughly with the extent of the settlement. Such regular arrangements at once differentiate urban centres from rural communities. Large centres cannot well be shown by dot-nets because of the space required. Urban populations about a certain number, varying with the dot-unit chosen, are shown by large spheres the volume of which is proportional to the unit-dot and decided by the population of the centre. Thus in the Swedish map the unit-dot, representing 100 persons, has a radius of 0·57 mm., and the sphere representing Stockholm (371,000 inhabitants) has a radius of 8·9 mm. These large spheres are shaded to give a spherical appearance. As the quantitative value of the larger sphere is not readily estimated, it is expressed in units printed on or beside it.

Much geographical judgment must be used in the placing of the dots, especially in rural districts. The population of isolated farms and small hamlets has to be gathered into groups of 100 if that is the unit chosen. The dot is placed either at that place with more than half this number of inhabitants or, if there is no such place, near the centre of gravity of the group. Due regard must also be had to the density of neighbouring groups, particularly near administrative boundaries. The map is further improved by tints of colour distributed to show relative density of population. Mr. de Geer rightly claims that such a population map has many practical applications in questions of the readjustment of administrative boundaries, of the establishment of public institutions, of lines of communications, of the location of educational facilities, of the stationing of officials, and in other directions.

The International Fishery Investigations.[1]

THE International Council for the Exploration of the Sea met at Copenhagen in July last, and the official account of the proceedings is now available. An unofficial report, with some criticisms, has also been published by M. Ed. le Danois. At this meeting Belgium, Denmark, Finland, France, Great Britain, Holland, Norway, and Sweden were represented, and negotiations are in progress for the inclusion of Spain, Portugal, Esthonia, and Lettonia. The Governments of Canada, Newfoundland, and the United States have meanwhile adopted a joint scheme of oceanographical investigations, and contemplate "establishing contact" with the European organisation.

The official report summarises the proceedings of the council, the sections, and committees; the latter relate to investigations on the herring, cod and haddock, plankton, hydrography, limnology, statistics, the Atlantic slope, the Baltic, and the plaice. Programmes of the researches contemplated in each of these subjects are given, and there are indications of the share taken by each country and of the limited progress that has been made. So far little has been published. M. le Danois's unofficial report is, in part,

[1] Rapports et Procès-Verbaux des Réunions: Conseil International, Exploration de la Mer, vol. 27, Copenhague, December 1921.
Notes et Mémoires, No. 11, Office scientifique et technique des Pêches Maritimes, Paris, December 1921.

critical. He finds the methods that have been adopted by the council much too theoretical and too purely scientific. He hopes much from the British delegates, who also wish to see the work directed more strictly towards the treatment of practical problems. These reflections are very interesting.

The first practical outcome of the fishery investigations is the report of the Plaice Committee. For twenty years the question of the depletion of the plaice-stock of the North Sea has been under investigation, but the study of the post-war conditions has now hastened consideration of all the evidence. The workers associated with the International Council hold that a progressive impoverishment was in progress up to the year 1914, and that the great restrictions on fishing due to the war arrested this decline and restored the plaice population of the North Sea. They ask that restrictions on fishing should be imposed so as to prevent the recurrence of the pre-war overfishing. They recommend that the North Sea between latitude 52° and 56° and within the Continental coast and the 12- or 15-fathom contour line be closed to steam trawlers and high-power motor vessels for the whole or part of the year. They also recommend transplantation of small plaice from this closed area to the Dogger Bank.

The fishing industry strongly opposes any restriction on fishing outside the three-miles limit, and it is now evident that this objection will be fatal to the adoption of the recommendations of the Plaice Committee. Any restriction of this kind is bound to lead to decreased profits or earnings at the time of its imposition. As a rule traders take a very short view of the circumstances in question, and are not inclined to make personal sacrifices in order that future generations of traders may obtain advantage. They hold that the evidence available does not justify the Government in accepting the recommendations noted above. Would *any* evidence bring about such industrial altruism? It is doubtful. In the present case, however, the evidence that is available has either not been published or it is presented in such a way that it does not easily appeal to the owners of fishing vessels. Obviously, such restrictions as are indicated must be made and enforced against the strong opposition of the fishing trade and with the approval of the public, and if that is to be so, the fullest publicity should be given to all the data on which the recommendations of the Plaice Committee are based. It is understood, however, that the passion for economy on the part of the Treasury and Stationery Office is now preventing the publication of expensive official scientific reports, and, that being the case, the attitude of the trade is, perhaps, quite justifiable.

J. J.

Gametic and Zygotic Sterility.

A FORM of pollen-sterility in which the anthers are aborted and the flowers fail to open is described by Dr. Bateson and Miss Gairdner (*Journal of Genetics*, vol. 11, No. 3) in flax. Some flowers produced a little pollen, and when self-fertilised gave rise only to male-sterile plants. This male-sterile form appeared as 25 per cent. of the F_2 of a cross between a procumbent variety of *Linum usitatissimum* and the pollen of a common flax. Later it was found that the sterility was determined by the pollen of this flax, the procumbent variety being genetically hermaphrodite on both the male and female sides.

In the same periodical Mr. Rudolph Beer makes a study of the cytology and genetics of Fuchsias, in which partial sterility of pollen and supernumerary pollen-grains are well known to occur. He finds that a pure species, *F. arborescens*, produces a large proportion of sterile pollen, while a cross between the distinct species *F. pumila* and *F. alpestris* shows regular pollen-development and very few bad grains. Such results have an interesting bearing on the hypothesis that bad pollen is in itself a criterion of hybridity. Some of the crosses result in "false hybrids" similar to those obtained in strawberries.

An interesting case in which ratios are altered through zygotic sterility, or rather weakness in development of a zygotic type, is described in the same journal. Mr. Bungo Miyazawa describes a dwarf type of barley which apparently arose as a mutation, and without exceptional care is capable of surviving only in the heterozygous condition. Thus dwarf plants when self-pollinated gave 2 dwarfs : 1 tall, but by careful germination of the seeds the homozygous type was enabled to survive, and was found to be an extreme dwarf which was sterile, producing no flowers.

Prof. E. M. East (*Genetics*, vol. 6, p. 311) has studied the partial sterility in hybrids between *Nicotiana rustica* varieties and *N. paniculata*. Nearly all the F_2 plants resemble *rustica*, a few are almost identical with *paniculata*, while many expected combinations of the parental characters are missing. The sterility varies from almost complete abortion of pollen and seeds to nearly complete seed fertility. This followed a condition of high sterility in F_1, in which only about 3 per cent. of the ovules were functional and only 35-55 per cent. of the seeds would germinate. The pollen-sterility of F_1 plants is even higher, probably not more than 0·1 per cent. of the possible grains from the pollen mother-cells reaching functional maturity. Many break down in the reduction divisions, and many apparently perfect grains dry up when the anther opens. Nearly all the F_2 plants show an increased fertility. The results are explained in terms similar to Goodspeed and Claussen's hypothesis of reaction systems. In brief, certain chromosome combinations are non-viable or produce offspring in which again only certain recombinations can survive. Prof. East suggests that many cultivated plants have originated from similar crosses in which a high degree of sterility has been followed by greater fertility in certain surviving strains.

Further light has been thrown on the sterility in wheat hybrids by the fact that the different types of wheat fall into three groups, which appear to have multiples of 7 as their chromosome numbers. Dr. Karl Sax (*Genetics*, vol. 6, p. 399) finds that the pollen-grains show a corresponding increase in size, the average relative volumes being 72 for Einkorn, 94 for Emmer wheats, and 114 for *T. vulgare*. This is to be expected with an increase in chromosome-content. The results of many investigations indicate that, in general, there is fertility in crosses within each group where the chromosome numbers are the same, but more or less sterility in crosses between forms belonging to different groups. Dr. Sax finds that in fertile crosses of wheat species the F_1 grains (endosperm) are larger than in the parent—a phenomenon of hybrid vigour—but in crosses which are partly sterile the grains are small and wrinkled. The degree of sterility may be determined by the amount of grain set, or by the amount of aborted pollen. There is much variability in the size of pollen in partly sterile F_1 hybrids, which is probably due to irregular chromosome distributions.

R. R. G.

Some Aspects of Cotton Growing.

THE great importance of the cotton crop in certain countries has led to special attention being paid to the deterioration in yield and quality that occurs in certain areas and to methods whereby improvements may be effected.

In Egypt (Bull. Imperial Inst. 19, No. 2) the decline in yield may be attributed chiefly to degeneration of the productive power of the soil, the ravages of insect pests, and to agrarian disturbance. To give satisfactory crops cotton, should be grown only once in a three-year rotation, but this limit has frequently been exceeded, with the natural result that the soil ingredients have been drawn upon unevenly, thus upsetting the balance of fertility. This could have been remedied by the judicious use of fertilisers, but for various reasons this has not been carried out. Even where manures have been used much harm has been done by the introduction of noxious substitutes by unscrupulous dealers. Excessive cotton cultivation has also been encouraged by the practice of leasing land for short three-year periods, the highest rents being paid to landowners who permit the greatest amount of cotton to be cultivated within the period of the lease without insisting on the re-establishment of the fertility of the soil for future tenants.

Another harmful factor is the prevalence of waterlogging. Since the Assuan Reservoir came into use, more water has been available for irrigation, and in addition the water table has risen, so that the drainage is now imperfect, and the roots of the cotton plant suffer from asphyxiation due to the consequent lack of air supply. The damage is aggravated by harmful salts which are now brought into solution near the soil level, and by surface evaporation remain within the area of growth of the cotton roots.

Until about 1912 the cotton worm was the most serious insect pest, but was eventually brought under control. Of recent years the pink boll-worm, first discovered near Alexandria in 1911, has become of paramount importance owing to its rapid spread through nearly all the cotton-growing countries of the world. Its life-history and habits rendered impossible the production of late-maturing cotton, as the late-formed bolls are badly attacked and the lint rendered useless for spinning purposes. Legislative measures are now in force for the uprooting and burning of the cotton plants before the end of the year, and for the treatment of the seed by hot air, whereby the resting worms are destroyed while the germinating power of the seed is not affected. It is hoped that the attacks of each pest will thus be reduced, and that the yield of cotton will, in consequence, be increased.

Agrarian disturbances have also caused much trouble, as the cultivators joined in the destruction of the means of transport, whereby difficulties arose in marketing the cotton and also in connection with seed distribution for the next season's crop.

Deterioration of quality has been considered in the case of Cambodia cotton (*Gossypium hirsutum*) grown in India (*Agric. Journ. India*, vol. 16, part 3). For some years after its introduction in 1907 the quality of its lint was good, but of late years it has been asserted that the lint is shorter, weaker, and much more stained than was the case at first. The weakness and staining are attributed to attacks of the pink boll-worm, and the loss can only be cured by the reduction of the pest. The shortness of staple, however, is due to the fact that the first seed distributed included a mixture of types. The early and more vigorous types, with poorer quality staple, were the better suited to the climate and to the rather haphazard methods of cultivation, and therefore flourished at the expense of the better quality types with longer staple. The line of improvement it is proposed to follow is that of isolation of types by means of single-plant selection and self-fertilisation, followed at a later stage by hybridisation to produce a type combining in itself all the most useful characters. If a more productive type can thus be produced and the loss caused by insect pests be controlled, considerable increase of yield per acre may be secured.

In this connection attention may be directed to an article on the commercial utilisation of cotton stalks (Bull. Imperial Inst. 19, No. 1). Enormous quantities of stalks are available after the crop is harvested, and as they afford harbourage for insect pests their destruction is of much importance. Locally the stalks are used as fuel, and in some districts supplies would not be available for other purposes. A fibre resembling that of jute, however, can be obtained from the bark, and possibly the longer fibre might be used as a substitute for the lower grades of Indian jute, and would probably realise rather less than half the price of Bengal jute.

Preliminary paper-making trials indicate that when treated by the caustic soda process, Indian cotton stalks yield paper pulp of fair quality which can be bleached to a pale cream tint, and the results are promising enough to deserve further consideration on the spot in India. Distillation experiments have also been carried out both in Egypt and England; good quality methyl alcohol and acetate of lime have been produced, but the charcoal and tar are of less value. In India the feasibility of distilling cotton stalks successfully would depend upon finding local markets for the products, particularly the charcoal and tar.

The Geographical Distribution of the Palm Pritchardia.

THE Bernice Pauahi Bishop Museum of Honolulu has recently issued (Memoirs, vol. 8, No. 1) an elaborate monograph of the palm genus Pritchardia by the late Prof. Odoardo Beccari and Prof. Joseph Rock. It is mainly the work of Prof. Beccari, and forms part of a larger monograph which he had prepared for later publication in the Annals of the Calcutta Botanic Garden. The material for the monograph has been largely supplied by Prof. Rock, who has discovered twenty-one of the thirty-three species described.

The study of the genus is of special interest from the point of view of geographical distribution. It is one of the most characteristic genera of palms of the Polynesian flora, but has attained its greatest development in the Hawaiian Archipelago, where it is the only palm found. It also supplies one of the most interesting problems in the geographical distribution of the family in the existence of a single species in the New World, namely, in Cuba and the Isle of Pines. This may be compared with the presence in South America of a representative of the African genus Raphia and of the solitary representative of the typical American Cocoineæ, namely Jubæopsis, in South Africa. How the fruits of the progenetrix of the Cuban species were enabled to cross the wide space of ocean between the nearest Polynesian islands and the American continent is a mystery. Prof. Beccari suggests the possibility of the transfer of fruits by means of the violent volcanic phenomena which

must have occurred during the elevation of the Andean ranges; at such a time a water communication may have been established between the two oceans and the fruits of a Polynesian Pritchardia deposited on an island in the Caribbean Sea.

The fruits, which are plum-like in structure, but with comparatively little flesh, vary in the different species from the size of a large pea to that of a date. The smaller ones would attract pigeons, which, though now unknown in Hawaii, may at some time, when greater land connections existed between the remoter islands of eastern Polynesia and those of Papuasia and western Polynesia, have contributed to stock the islands of the Hawaian group. But there is still the difficulty of explaining the presence of large-fruited Pritchardias on the most inaccessible summits of the mountains of Hawaii. Prof. Beccari suggests that these represent a surviving element of the vegetation which covered the plains before the cataclysms which resulted in the elevation of the present mountains and broke into fragments the originally much more extensive land area. The monograph is illustrated by twenty-four plates, mainly reproductions of photographs taken by Prof. Rock.

Agricultural Experiments at Ithaca, N.Y.

THE Report of the Agricultural Experiment Station of Ithaca, N.Y., for 1919 contains a number of memoirs of considerable interest, especially from the botanical and entomological points of view.

Work on the stimulation of growth by various chemical compounds indicates that treatment with potassium permanganate may result in a very marked increase in the root-growth of various woody cuttings. Other compounds of manganese, iron, and boron may show at times a slight stimulating effect, but nutrient solutions are, as a rule, injurious to the root-growth of cuttings. In another paper the effect of manganese compounds on soils and plants is discussed. The general conclusion reached is that with wheat, manganese salts presented in high concentrations exert a toxic effect, but in lower concentrations a marked stimulation is observable. When added to soil, manganese salts were found to form manganese dioxide in proportion to the basicity of the soil and to develop a power to oxidise organic matter.

In genetics two papers deal with chlorophyll inheritance and aleurone colour in maize, and another with the weak awn in certain Avena crosses. In some crosses of awned and awnless varieties (as Burt and Sixty Day) there is an almost complete dominance of the awnless condition, the factor for awning being apparently prevented from operating by an inhibition which is closely linked with the factor for yellow colour in the variety concerned. Environment seems to affect the production of awns, and observations suggest that an increase in the moisture-content of the soil and of its organic matter and nitrogen tends to decrease the number of awns.

Soil conditions are dealt with in memoirs on the translocation of calcium and on the reversibility of the colloidal condition of soils. In the first case it was found that the translocation of calcium through a clayey silt loam soil with a rather large lime requirement is extremely slow, since in the experiment no upward or downward movement of this element was perceptible twelve months after various amounts of calcium salts had been applied to the soil. In the second case it was demonstrated that drying a surface soil once produces as much effect in the colloidal material as repeated dryings alternated with moistenings, the drying producing a change in the colloidal material from which it does not immediately recover on being wetted. The drying indirectly affects the reversibility of its colloidal condition, the change being directly produced through biological and chemical action.

On the bacteriological side attention is directed to the effect of low temperature on soil bacteria and to the number and types of bacteria found in ice-cream during storage. In the soil there appears to be no change in the bacterial flora due to freezing, the bacterial activities being influenced only in so far as the physical properties of the soil are affected. The concentration of the medium, the length of time of exposure, and the degree of cold are the three important factors that determine the power of resistance of the bacteria to low temperature. The death of the bacterial cell when exposed to low temperature seems to be due to the withdrawal of water from the semi-permeable membrane or outer layer of the cell.

An outline is given of the life-histories and methods of control of various insects injurious to the hop in New York, special attention being devoted to the hop grub (*Gortyna immanis*, Guenee) and the hop redbug (*Paracalocoris Hawleyi*, Knight). The hop grub causes considerable financial loss, and in years when the insects are plentiful they may cause an almost total loss to some growers. The larvæ damage various parts of the vine, working in the buds, stem, and roots, thus weakening the plants in various ways. For control, clean cultivation is advised, with a ploughed border several yards wide round the field. The use of carbon bisulphide as an insecticide is unsatisfactory, but paradichlorobenzine has been successful when added to the soil of each hill in May.

The plant-lice injuring the foliage and fruit of the apple (*Aphis pomi*, de Geer, *A. sorbi*, Kaltenbach, and *A. avenæ*, Fab.) are described and fully illustrated, and the first part of a detailed systematic account of the crane-flies of New York is issued, dealing with the distribution and taxonomy of the adult flies.

W. E. B.

The Lhota Nagas.

AT a meeting of the Royal Anthropological Institute held on March 14, Dr. W. H. R. Rivers, president, in the chair, Mr. J. P. Mills, of the Indian Civil Service, read a paper on the Lhota Nagas of Assam. He said that in spite of its long contact with the plains of Assam, this tribe has retained its primitive dress and customs. It occupies a portion of the Naga Hills lying to the S.E. of the Brahmaputra Valley, and numbers some 18,000 souls. Like the Angamis, the Lhotas trace their origin to a mythical hole in the earth near the Kezakenoma stone. In dress they resemble closely their neighbours, the Aos, the men wearing a small apron and body cloths of various patterns, and the women a small skirt of very dark blue, with a light blue median band. Warriors in full dress wear human hair tails, elaborate baldricks with fringes of goat's hair dyed scarlet, and bear's hair wigs ornamented with hornbill feathers.

The villages, which are permanent, may contain any number up to 300 houses and are built on the tops of the ridges. The highest is at about 5000 feet. Each village contains one or more "bachelors' halls" in which boys and unmarried men sleep. In the middle of the village stands the head-tree, usually a *ficus*, on which heads taken in war were hung. Under it are

kept the "luck-stones" of the village, to which the Lhotas attach great importance. Other "luck-stones" are kept in the "bachelors' halls" and in the houses or granaries of individuals. Cultivation is of the shifting type known as *jhuming*, and there are numerous ceremonies connected with it.

The tribe is composed of three *phratries*, each of which contains a number of clans, which are in turn often subdivided into kindreds. Formerly a man was forbidden to marry a woman of his own *phratry*, but now intermarriage in the clan is often allowed provided the parties are of different kindreds. The classificatory system of relationships obtains. Inheritance is in the male line. Each village is run as a separate unit by an informal council of old men, and has an old man duly qualified who takes the lead at religious ceremonies. They believe in no Supreme Being, but in a world of godlings above the earth. The underworld is occupied by the dead, and elaborate precautions are taken at funerals to ensure that the soul goes there in comfort. Each male Lhota tries to perform the full series of feats of merit, and, like the Angami, sets up a monolith to mark their completion. A man's cloth varies according to the stage which he has reached in the series.

The Development of Ceylon.[1]

CEYLON has large and successful agricultural industries, and in 1916 a Commission was appointed to consider the development of existing industries and the establishment of new ones, in other branches of activity. The report of the Commission has just been issued, and is a very practical document, fully recognising that scientific knowledge is only one item, and that not the chief, in ensuring success. Many industries, desirable in themselves, do not offer sufficient financial prospects to attract any one away from the established agricultural and other trades.

The report goes on to say, "We have been profoundly impressed by the importance of scientific research in the progress and development of most of the industries we have examined"; and this theme is developed at some length, the final recommendation being that as private individuals can rarely afford the cost of the necessary research, this should be largely the affair of the Government, which is urged to establish a Bureau of Industry and Commerce, that should aim at a greater degree of co-ordination between the various scientific departments, and prevent overlapping of work. It should also establish a central Economic Museum, collect and collate statistics, foster new industries, aid them with scientific and other advice, and do other things. This would involve the establishment of a staff of research workers, and it is to be hoped that they may be generously paid, for, as it has been said, "A paternal Government may desire investigations to be made on some defined subject, and may duly engage an explorer to map that bit of country. . . . Then the poor sportsman, if he is to carry out his part of the agreement, is no longer free. And in that case he deserves good pay for the surrender of his freedom."

It is first pointed out that industries cannot be established without power, and as Ceylon has no coal this power must be hydro-electric. There are indications, however, that some scheme of utilisation of the considerable amount of water power that runs to waste in the hills may soon be put in hand.

Various possible industries are then considered, in which, bearing in mind the above considerations, it is conceivable that success might be attainable. Cement, for example, is considered to have little prospect, inasmuch as Ceylon could not consume the whole output of a factory large enough for proper efficiency. Spinning and weaving, on the other hand, offer good prospects, if the cultivation of cotton can be extended, for there is a large local demand, and the excellent wearing capacity of the cloth made from the short-stapled Indian cotton has already been fully proved.

The possibility of providing the wood used for the making of the vast numbers of chests used for packing tea, rubber, etc., is then considered, and it is thought that, with proper attention to seasoning, Ceylon should be able to supply all her own material, provided that the requirements of the grower of the wood, the maker of the box, and the user of the same, can be properly harmonised—a matter which would fall to the suggested Bureau.

For the encouragement of home industries, such as weaving, silver and brass work, embroidery, and the like, the establishment of a central School of Arts and Handicrafts is recommended.

The question of the fisheries is then dealt with, and it is pointed out that while there is more fish available in the sea than the island requires, it nevertheless imports to the value of about Rs.6,000,000 yearly. It is suggested that a Department of Fisheries be established, in place of the Marine Biological Department so ably carried on by the present Director of the Colombo Museum in addition to his other duties. This new department should attend, among other things, to increasing production, to improvement in methods of curing, to canning (for example, of sardines, which are plentiful), to the manufacture of fish manure and oils, to freshwater fisheries, pearl fisheries, chank, window-pane oyster, and bêche-de-mer fisheries, to encouragement of research, and other things, in all of which there seems to be great opening.

It is further suggested that experiments should be made with such industries as the manufacture of glass, cyanamide, paper, soap, etc.; and the improvement of the mining industry is also considered.

In conclusion, stress is laid upon the necessity for wise action by the State in regard to provision of power, and establishment of the Bureau above mentioned, when it is considered that industries dependent upon forestry and fishing would show the most promise. It is also urged that the youth of Ceylon be given the opportunity, by technical training, etc., of taking part in any future industrial development. The whole report is of a practical and statesmanlike character.

[1] Report of the Industries Commission, Ceylon. (Sessional Paper 1 of 1922.)

University and Educational Intelligence.

CAMBRIDGE.—The Allen Scholarship has been awarded to J. C. Burkill, Trinity College.

The annual report of the Appointments Board shows a total of 349 men placed in the past year, the highest figure for the past nine years. In view of the prevailing conditions in the industrial and commercial world, this is a satisfactory report. The chief subjects in which men have been placed by the Board are: Educational appointments, 143; administrative appointments in commerce and industry, 65; manufacturing and technical appointments, 47.

OXFORD.—Mr. A. L. Dixon, Fellow and Tutor of Merton College, has been appointed Waynflete Professor of Pure Mathematics in succession to Prof. E. B. Elliott.

THE honorary degree of Doctor of Science has been conferred on Sir Thomas Muir by the University of Cape Town, in recognition of his researches in mathematics and mathematical history. Sir Thomas Muir was Superintendent-General of Education for

Cape Colony from 1892 to 1915, and for the greater part of that period he served as a member of the council of the University.

THE Royal Academy of Belgium announces that a triennial prize of 2500 francs, to be known as the Prix Joseph Schepkens, for the best experimental work on the genetics of vegetables, has been established.

THE Research Chair of Medical Psychology in the University of Queensland, Brisbane, has been filled by the appointment of Dr. J. P. Lowson, University Demonstrator in Experimental Psychology at Cambridge. It is expected that Dr. Lowson will arrive in Brisbane early in this month.

THE Hull Corporation recently endeavoured to purchase nineteen acres of land on the outskirts of the city, adjoining the Hull Training College, for the purpose of a Technical College, the present building, near the centre of the city, being too small and inconvenient. The Board of Education, owing to national financial stringency, turned the matter down. The Rt. Hon. T. R. Ferens, formerly M.P. for East Hull, has now purchased the land for ten thousand pounds and presented it to the Hull education authority. Mr. Ferens has previously given about 40,000*l*., for the erection of a new Art Gallery, 10,000*l*., for the purchase of pictures, besides other amounts for the erection and endowment of almshouses, and in numerous other ways has placed the citizens of Hull under a deep debt of gratitude.

THE interest in the eighth report of the Carnegie United Kingdom Trust for the year ending December 31, 1921, centres round two schemes to which the Trust has definitely committed itself—(*a*) to provide facilities for reading in the rural districts, and (*b*) to supplement the resources of library authorities throughout the United Kingdom by regional centres of book distribution. The launching of these two schemes was preceded by a very careful sufvey of the whole question of library policy, the results of which are beginning to bear fruit. There are now 39 county schemes in operation in Great Britain, *i.e.* schemes administered from county headquarters, from which boxes of books are circulated to the village centres—the distributing agent in the village being usually the local teacher. Thus the county library and education authorities are brought into direct connection—the local teachers working under the direction of the county librarian. This method has worked satisfactorily. Past experience, however, teaches that little value is to be placed on initial success. When the novelty of the experiment and of the books circulated wears off, the interest of readers wanes and the system falls into disuse. Against this the Trust has wisely provided by the provision of regional book stores—of which three centres are already established in London, Dunfermline, and Dublin—the last named being still in its embryo stage. In Wales the National Library at Aberystwyth has for some years supplied this want. In these centres a large and well-selected stock of books has been accumulated which should go far toward satisfying the requirements of serious readers not only in the villages but also in the smaller borough and urban districts. Thus equality of opportunity now exists throughout Great Britain for self-education, and this result has been secured with a minimum expenditure on the machinery of administration. Amongst the miscellaneous grants we note with pleasure that a generous, though final, donation has been made to the Library Association in respect of its "Subject Index to Periodicals." We understand that the Class List "Science and Technology" for 1917–19 is in the press and will be issued shortly.

Calendar of Industrial Pioneers.

March 23, 1875. Thomas Lloyd died.—Trained as a shipwright at the School of Naval Architecture at Portsmouth, Lloyd was detailed by the Admiralty for duty with the early naval steam vessels, and ultimately became the first Engineer in Chief of the Navy, a post he held from 1847 to 1869. He was born in 1803, and his services extended from the introduction of steam into the Navy to the development of the first mastless steam ironclad, H.M.S. *Devastation*.

March 24, 1879. Karl Karmarsch died.—Born in Vienna in 1803, Karmarsch founded, and for forty-five years directed, the Polytechnic at Hanover, and wrote valuable works on mechanical technology.

March 25, 1864. Francis Baird died.—Second son of Sir Charles Baird, the founder of the well-known works at St. Petersburg, Baird for many years was sole proprietor of the establishment, and as such carried out numerous important contracts for the Russian Government.

March 25, 1905. Bruno Kerl died.—A distinguished German metallurgist, for thirty years a professor at the Berlin School of Mines, Kerl was the author of valuable treatises, and for thirty-eight years edited a mining and metallurgical journal.

March 25, 1912. Antonio Pacinotti died.—One of the pioneers of the dynamo, Pacinotti was educated at Pisa, where his father was a professor. He served in the Garibaldean wars, and on his return to Pisa in 1860, at the age of 19, constructed the ring-armature dynamo, a form of dynamo re-invented ten years later by Gramme. Though unnoticed at first, Pacinotti's work ultimately received recognition and he was awarded various honours. He held professorships at Florence, Cagliari, and Pisa, where he died.

March 26, 1865. Thomas Hancock died. — The great pioneer of the British rubber industry, Hancock took out his first patent in 1820. He afterwards perfected a process of mastication, and in 1843, having seen samples of the "cured" rubber of Goodyear, patented a method of "vulcanising" rubber by sulphur, and was the first to make vulcanite or ebonite. With his brothers he founded the firm of James Lyne Hancock. In 1857 he published his "Personal Narrative of the Origin and Progress of the Caoutchouc or Indiarubber Manufacture in England."

March 26, 1858. John Seaward died.—In 1824, after experience in many branches of engineering, Seaward opened the Canal Ironworks at Millwall, and became one of the principal builders of marine engines for the Navy. Assisted by his brother Samuel, he made many improvements in paddle-wheel machinery, and introduced the "Gorgon" type of direct-acting engine.

March 28, 1919. Henry Wilde died. — Left an orphan at 16, Wilde began life as an engineering apprentice in Manchester. In 1856, at the age of 23, he set up in business as a telegraph and lightning conductor expert, achieving his first success with an alphabetical telegraph. In 1863 he began his work on the dynamo, which with his electro-chemical discoveries laid the foundation of his fortune. He retired from business in 1884, devoted much time to scientific research, and became well known for his generous gifts to scientific institutions.

E. C. S.

Societies and Academies.

LONDON.

Association of Economic Biologists, February 24.—Sir David Prain, president, in the chair.—J. **Rennie**: The present position of bee-disease research. There is a general similarity of symptoms in all adult bee diseases. With the recognition of the parasite, *Nosema apis*, in association with bee disease there has been at the same time a failure to appreciate a preponderance of cases of disease from which this organism was absent. Recent work at Aberdeen has shown that there are at least three adult bee diseases of importance prevalent in this country—all of which have hitherto been called Isle of Wight Disease. Besides Nosema disease, there are Acarine disease and Bee Paralysis. At the present time Nosema disease is less common than Acarine disease, but appears to be maintained to some extent by the importation of foreign bees, a proportion of which contain the parasite, *Nosema apis*. Acarine disease is the more formidable malady; its causal agent is a Tarsonemid mite which breeds in the thoracic tracheæ and feeds on the blood of the bee. An important feature in this disease, which has hitherto rendered control measures difficult, is the long period of infestation while the mite is being established in the colony, during which time the presence of the parasite is unsuspected. The systematic examination for this parasite of all stocks should be the first step in control. Bee paralysis, described by the Swedish investigator Turesson as an intoxication due to phenolic acids developed in the combs and pollen by the growth of various moulds, has also been recognised in Great Britain.—J. **Rennie**: Polyhedral disease of tipula species. Larvæ of *Tipula paludosa*, the fat body cells of which contain polyhedral bodies in the nuclei, do not complete their development; they die before pupation. This affection, known in various Lepidopterous larvæ, has not hitherto been observed in Diptera. The polyhedra appear to be developed in association with a virus. Infection by feeding is readily produced, and polyhedral bodies develop within the fat body cells in some six or seven days.

Linnean Society, March 2.—Dr. A. Smith Woodward, president, in the chair.—R. E. **Holttum**: The flora of Greenland. During the summer of 1921 a visit was paid to Disko Island and parts of the west coast of Greenland. The most widely-spread vegetation is a low heath of *Empetrum nigrum Cassiope tetragona*, etc. In specially protected localities a scrub of *Salix glauca* was found, which may reach eight feet in height, accompanied by herbaceous plants of southern type. In unfavourable situations there are isolated plants of resistant herbaceous and woody species. The flora of the whole of Greenland consists of 416 species of vascular plants, of which 18 per cent. are high arctic in type, 22 per cent. widely distributed, and 60 per cent. of southern type.—J. **Walton**: The ecology of the flora of Spitsbergen. The largest number of species in Spitsbergen occurs where continental conditions are approached; *e.g.* at the head of Klaas Billen Bay, near the centre of West Spitsbergen, an area of about 5000 square kilometres contains 90 per cent. of the species of vascular plants occurring in Spitsbergen. Three vegetational zones appear: raised shingle beach, alluvial land between mountain and beach, and scree slopes. The development of the flora of the two former can be traced to an intertidal zone which resembles the salt-marsh formation of lower latitudes.—Sir W. A. **Herdman**: Spolia Runiana—V. Summary of results of investigation of the plankton of the Irish Sea during fifteen years. The spring phytoplankton maximum ranges from March to June, and is chiefly composed of diatoms which vary greatly from year to year in maximal haul, up to over 200 millions. This immense diatom curve can be resolved into an earlier crest in April or May, chiefly formed of *Chaetoceras*, and a later in June, chiefly formed of *Rhizosolenia*. The Dinoflagellate maximum follows about a month later than the diatoms, and varies in our records from May to July (rarely August). The Copepod maximum is later again, and ranges from June to October. The largest hauls of plankton are obtained, during daylight, at a level of from 5 to 10 fathoms. The Irish Sea plankton contains from 30 to 60 per cent. of Oceanic forms, the rest are Neritic. Mid-winter and mid-summer are more oceanic in character than the intervening months. A comparatively small number of genera of Diatoms and Copepoda are the dominant organisms of the plankton, and these are the important food-matters for the nutrition of higher animals in the sea. It is probably impossible to draw numerical conclusions as to the population of large sea-areas from few and small samples of the plankton, for series of vertical hauls taken at the same spot in rapid succession show variation up to 50 per cent. The distribution of plankton in the sea is not uniform, and many animals such as Copepoda are present in swarms or patches. As suggested by Hjort, the survival of newly hatched food-fishes in early spring, upon which the prosperity of future commercial fisheries may depend, is possibly determined by the amount of phytoplankton present at the time.

Institute of Metals, March 8.—G. D. **Bengough**: Notes on the corrosion and protection of condenser tubes. Specific recommendations are made for the guidance of manufacturers of tubes and condenser plants.—F. **Adcock**: The internal mechanism of cold-work and recrystallisation in cupro-nickel. Cast cupro-nickel, annealed until homogeneous, can withstand considerable cold working and yet be sufficiently hard to permit of rapid preparation for micro examination. Material subjected to reductions of 50 per cent. and 88 per cent. by cold working was examined to investigate the nature and direction of certain strain planes passing through most of the crystal grains of the distorted metal. Cold-worked specimens annealed for fixed periods at progressively higher temperatures were also examined. The effect of annealing is at first the accentuation of the "strain" markings, followed at higher annealing temperatures by the appearance of new crystal grains, which, if on the sites of the "strain" lines, are frequently elongated in the direction of these lines. The Brinell hardness of the cold-worked metal did not begin to fall appreciably until the annealing temperature was such that new crystal grains were readily discernible under the microscope.—Research Staff of the **General Electric Company** (London): The effect of impurities on recrystallisation and grain growth. Tungsten wires were prepared containing known quantities of thoria, alumina, silica, lime and the alkali metal oxides, in various proportions, and changes in crystal structure on annealing at 2500° were followed. The refractory oxides, which ultimately segregate in the grain boundaries, exert a definite resistance to grain-growth. The alkali metal oxides have no influence upon grain-growth, but an exaggerated growth takes place on annealing tungsten containing a few tenths per cent. of both a refractory oxide and an alkali metal oxide. Single crystals occupying the entire cross-section of the wire, and three hundred times as long as their diameter, are formed on annealing for a

fraction of a minute. Crystal growth and recrystallisation in metals probably depend on a difference in vapour pressure between neighbouring crystal grains. This explains the known phenomena in relation to the effect of strain, grain-size, and temperature in regulating recrystallisation and grain-growth on annealing.—H. **Moore** and S. **Beckinsale**: Further studies in season-cracking and its prevention: condenser tubes. The properties of various condenser tubes were determined before and after annealing at temperatures in the range 250°-325° C. By annealing experiments on flat strips of condenser-tube brass elastically bent to an arc of a circle and thus initially stressed to a known amount the effects of initial hardness, initial stress, time, and temperature, on the reduction of initial stress by low-temperature annealing were determined quantitatively. The rate of reduction of stress at the lower temperatures is rapid, but slows down when the stress has been considerably reduced. The higher the initial stress the higher is the remaining stress in brass of the same hardness, and the higher the hardness the lower is the remaining stress for a given initial stress. A temperature of 250°-275° C. is very effective in restoring elasticity in the overstrained material. Treatment at 280°-300° C. for 30 mins. reduces initial stress to a safe limit without injury to, and in some cases with marked improvement in, the strength of the tube.

March 9.—W. **Rosenhain**: Some cases of failure in "aluminium alloys." Some "aluminium alloys" undergo distortion and disintegration; they usually consist mainly of zinc and are not properly described as aluminium alloys. Such alloys, consisting largely of zinc and also containing aluminium and copper, are unstable at ordinary temperatures and liable to changes of dimension and disintegration. True light alloys of aluminium (consisting mainly of aluminium), if properly prepared are free from any risk of serious growth or disintegration.—F. C. **Thompson** and E. **Whitehead**: Some mechanical properties of the nickel-silvers. The effect of annealing at different temperatures, and the different rates of cooling after annealing, upon the tensile properties, the Arnold alternating stress values, and the Erichsen values of hard-rolled alloys containing 10, 15, and 20 per cent. nickel were examined. Changes occur at about 300° C. and 550° C. Annealing at 300° C.-400° C. results in a material of very low ductility. The best annealing range for the 10 per cent. nickel alloy is 725° C.-825° C.; for the 15 per cent. nickel, 700° C.-800° C.; and for the 20 per cent. nickel alloy, about 800° C. As the nickel content is raised the tensile strength is raised, while the maximum ductility is considerably reduced. As regards Brinell hardness almost the whole of the softening takes place in the first two hours. The greatest ductility and the highest Erichsen values are obtained after annealing for 1½ hours for small samples. There is little to choose between annealing for a short time at a high temperature and for a longer time at a low temperature. The alloys can be heated to a high temperature without deterioration, especially when the sample is protected from oxidation. The Erichsen tests show good results even after annealing at 850° C.—D. **Hanson** and Miss M. L. V. **Gayler**: A further study of the alloys of aluminium and zinc. Alloys containing 70, 60, 50 per cent. of zinc when slowly cooled to 284° C., after prolonged annealing at 420° C. and quenched are duplex in structure. A redetermination of the solidus from 81-20 per cent. zinc showed that the line representing the peritectic reaction extends to a composition of 70 per cent. zinc as against 40 per cent. zinc in previous diagrams. Microscopic examination of alloys, following special heat-treatment, disproved the existence of the compound Al_2Zn_3, and showed that the nature of the change in the alloys at 256° C. in Rosenhain and Archbutt's diagram is identical with an ordinary eutectoid transformation, the decomposition of the β-phase leading to the "pearlitic" structure commonly found in the alloys. Below 256° C. the solubility of the α-constituent in the γ-constituent decreases with the temperature. Alloys containing the β-constituent harden spontaneously at room temperature after being quenched from above 256° C.; those containing the γ-constituent showed the same property in a much less marked degree.—A. **Westwood**: The assay of gold bullion. The assay sample is not cupelled but is melted and balled up under steam or an inert gas. For the usual inquartation copper is recommended in place of silver.—C. A. **Edwards** and A. J. **Murphy**: The rate of combination of copper and phosphorus at various temperatures. When using ½-inch copper rod the maximum rate of increase of phosphorisation in phosphorus vapour for a given rise of temperature occurred at 640° C. Phosphorisation at this temperature is quick and safe, and the operation can be controlled so as to prevent the formation of any liquid, while it is impossible to obtain an alloy containing more than the percentage of phosphorus which is required commercially.

CAMBRIDGE.

Philosophical Society, February 27.—Mr. C. T. R. Wilson, vice-president, in the chair.—G. F. C. **Searle**: (1) An experiment illustrating the conservation of angular momentum. A horizontal board is suspended by a practically torsionless silk thread. Attached to the board is a vertical pivot about which an inertia bar turns balanced by a suitable counterweight. The inertia bar is held by a thread in a definite position against the action of a spring and then the thread is burned. The spring turns the bar until its motion relative to the board is arrested by a stop and the board turns in the opposite direction. The ratio of the angles turned through by board and bar is equal to the ratio of the moments of inertia of the bar about its pivot and of the whole system about its axis. This ratio is found by means of a torsion wire. (2) A focal line method of determining the elastic constants of glass. Light from a collimator, with cross-wires in one focal plane, falls on the surface of a bar of glass. The reflected beam falls on a converging lens system which is adjusted so that the origin point on the surface is in one focal plane. A ground-glass screen on an optical bench is adjusted to be in the other focal plane. When the bar is bent, the cross-wires are set horizontal and vertical and the position of the focal lines of the reflected beam is determined. When the bar is twisted, the cross-wires are set at ±45° to the horizontal and similar measurements made. The glass bar is replaced by a concave spherical mirror and the measurements repeated. Young's modules, Poisson's ratio and the rigidity can be calculated.—G. **Stead** and E. C. **Stoner**: Low voltage glows in mercury vapour. The effect of varying pressures and filament temperatures on the glow potential of mercury vapour, and on the current changes accompanying the appearance and disappearance of the glow were investigated. The glow could be obtained in a dome-shaped form of variable length. At higher pressures the glow point occurred below the ionisation potential.—E. V. **Appleton**: An electric wave detector. The thermionic current of a diode vacuum tube in which the electrons move with very small velocity is deflected by the direct action of electromagnetic radiation.

The resulting reduction in the thermionic current is used to indicate the field strength.—E. B. **Ludlam**: An attempt to separate the isotopes of chlorine. Hydrogen chloride at a pressure of about two centimetres of mercury was passed over (*a*) a water surface, (*b*) ammonia gas, so that a small fraction was retained uncombined. The chlorine was weighed as silver chloride. Any increase in weight could be attributed to experimental error.—M. H. **Belz**: The measurement of magnetic susceptibilities at high frequencies. A heterodyne beat method is described, in which changes in inductance are produced by insertion of the specimen inside one of the oscillating coils. Susceptibility is calculated from the change of beat note. The range of frequency employed was 3×10^5 to 4×10^6 per second, and the results show that, up to this point, frequency has no effect.—G. H. **Henderson**: Note on an attempt to influence the random direction of a particle emission. On applying a magnetic field to radium emanation no change could be detected in the ionization due to beams of α rays parallel and perpendicular to the field.—J. E. P. **Wagstaff**: Determination of the coefficient of rigidity on a thin glass beam.

Dublin.

Royal Dublin Society, February 28.—Dr. J. A. Scott in the chair.—J. **Joly**: A new method of finding the discharge of rivers. This is a modification of the method of chemical hydrometry. A small quantity of uraninite in solution and diluted to a suitable volume is supplied into the river at a uniform rate for a period of 15 or 20 minutes. At a point lower in the river samples of water are taken. These, after a suitable interval, are examined for radium emanation. A river of 10^4 litres per second would require about 300 grams of pitchblende for a measurement aiming at an accuracy of one per cent. Ordinary chemical hydrometry would be much more costly and troublesome.—J. G. **Rhynehart**: On the life-history and bionomics of the flax flea-beetle (*Longitarsus parvulus*, Payk.), with descriptions of the hitherto unknown larval and pupal stages. This flea-beetle is a serious flax pest in Ireland. The adults feed on the leaves of the flax seedlings in May and early June and often destroy large areas. From eggs laid in the soil by over-wintered females are hatched minute larvæ which burrow into and feed upon the roots of the flax plants. Pupation occurs in the soil after about a month of larval life, and a new brood of beetles emerges during the last week of July and the first week of August. Various suggestions for controlling the pest were discussed, and the results of field experiments point to the fact that Bordeaux mixture tends to repel attacks.—E. J. **Sheehy**: The influence of feeding on milk fat. An investigation into the effect of increasing or decreasing the ration of three experimental goats indicated that the percentage of butter fat in milk may be increased to a maximum figure, or may be decreased, according to the mode of feeding. Fat, starch, or protein, when added to a poor ration, may raise the percentage of butter fat.—L. B. **Smyth**: On a variety of Pinite occurring at Ballycorus, Co. Dublin. A mineral occurring at the edge of the Leinster Granite is shown to be a hitherto undescribed variety of Pinite.

Edinburgh.

Royal Society, March 6, 1922.—Prof. F. O. Bower, president, in the chair.—Prof. J. G. **Gray** and Capt. J. **Gray**: Solutions of the problem of the vertical on moving vehicles with special reference to aircraft:—The Gray Gyroscopic Stabilisers. Prof. J. G. Gray communicated this paper on the action of various forms of the Gray Stabiliser, an instrument which was brought to the notice of the British Government early in 1915, and was adopted by the Royal Naval Air Service in 1917, and in 1918 received the approval of the Research Council of America. In 1918 Prof. Gray was invited by the American Government to visit America with a view to developing the instruments to the utmost for use in the American Aerial Services. Unfortunately, for reasons which cannot now be given, the instruments were not used by the British Services over the German lines. The Gray stabiliser does not aim at stabilising an aeroplane as a whole, but provides means whereby instruments of precision used on aircraft, such as horizon mirrors, bombsights, navigational sights, cameras, etc., may be stabilised with respect to the vertical and the horizontal, against both pitching and rolling motions of the aeroplane or airship. This stabiliser finds and maintains the true vertical (the direction assumed by the thread of a simple pendulum as set up in a room) with the utmost exactness on an aeroplane, and is thus available for trimming the aeroplane during cloud flying. The instrument consists of a main stabilising gyroscope, or gyroscopes, attached to the aeroplane by means of a gimbal frame and two sets of pivots. The instrument to be stabilised forms part of the pivoted system. Also forming part of this system is an erector consisting of a member which rotates slowly, on a vertical spindle, in the direction of spin of the main gyroscope, or gyroscopes. This member is provided with a set of compartments, each of which contains a solid spherical steel ball. The compartments are so shaped that, when the pivoted system is inclined to the vertical, the balls automatically arrange themselves so that the device is erected into the vertical by gyroscopic action, when the balls then automatically arrange themselves as a balanced system. An explanation was given of the various forms of erectors which had been devised; and it was shown how in each case the device was given a sense, so to speak, of the true vertical, but was rendered blind to the apparent vertical during curved flight. A bombing aeroplane, just previous to running up to a target, executes a rapid turning movement. The Gray stabiliser permits of all such manœuvres being carried out without the introduction of errors. The pioneer instruments, as tested on aeroplanes by R.N.A.S. officers in 1917, using sun-shadow methods of testing, methods which permitted of the accuracy of the instrument being ascertained beyond dispute, were found to have an accuracy of $\frac{1}{10}$th of a degree, or for bombing purposes an accuracy of about 25 feet on the ground from a height of 15,000 feet. The instruments were absolutely undisturbed by pitching and rolling motions of the aeroplane, even when the flying was carried out with the aeroplane side-on to half a gale of wind. The authors of the paper had been working continuously with a view to perfecting these gyroscopic inventions and were in a position to construct stabilisers, for use on aeroplanes and battleships, which would yield for navigational purposes, and for purposes of bombing and gunnery, an accuracy of one or two minutes of angle at the outside. Gray stabilisers for use with cameras are being constructed for use in the U.S.A. In conclusion Prof. Gray expressed his thanks to the War Committee of the Royal Society of Edinburgh, which in 1915 encouraged his researches in every possible way.—H. W. **Brolemann**: Myriapods collected in Mesopotamia and N.-W. Persia by W. Edgar Evans, B.Sc., late Capt. R.A.M.C. Seventeen species—twelve Chilopoda (centipedes) and five Diplopoda (millipedes)—mostly collected around Amara on Tigris and Ruz, N.-E. of Baghdad, are recorded. Five species and three

sub-species are described as new, and a new genus, *Calyptophyllum*, is erected for the reception of two of the Millipedes.

PARIS.

Academy of Sciences, February 27.—M. Emile Bertin in the chair.—M. E. I. Fredholm was elected Correspondant of the Academy for the section of geometry, and M. Henri Jumelle Correspondant of the Academy for the section of botany.—T. **Carleman**: The series $\Sigma\frac{A_\nu}{z-a_\nu}$.—S. **Sarantopoulos**: A theorem of M. Landau.—E. **Cartan**: A generalisation of the notion of curvature of Liemann and torsional space.—P. **Fox**: Measurements of stellar parallaxes at the Deadborn Observatory (United States). A table of the parallax of 34 stars, supplementing earlier lists given in 1919 and 1921.—T. **Moreux**: A new theory of the formation of the spiral nebulæ and of the solar system.—G. **Perrier**: Compensation of the differences of altitude of a chain of triangles of the first order. Application to the triangulation of the meridian arc of the equator.—M. de **Laroquette**: Measurement of the mean penetrating power of a bundle of X-rays by a new radio-chromometric method. Ten holes are bored in a sheet of lead, and these receive in turn known fractions (from 1 to 50 per cent.) of the total exposure. Twelve other holes are made in the same plate, and in these sheets of metal are placed discs possessing filtering power expressed in millimetres of aluminium, up to 66 mm. The scale thus obtained has been compared with Benoist degrees and possesses advantages over the latter in having a wider range and in being applicable to all radiations.—P. de la **Gorce**: The measurement of power by the differential dynamometer.—M. **Chapas**: The solubility of the isomeric toluic acids in the three xylenes. The para-acid is very slightly soluble in the three xylenes; the meta-acid is more soluble, but the differences from the ortho-acid are insufficient to form a method of separation.—A. **Poucholle**: Contribution to the study of tempering.—P. **Job**: The electrometric study of electrolysis, under the action of baryta, of some complex amine cobalt compounds.—J. B. **Senderens** and J. **Aboulenc**: The catalytic preparation of the cyclohexanetriols. Pyrogallol in alcoholic solution is rapidly reduced by hydrogen in the presence of nickel under a pressure of 40 to 50 kilograms at a temperature of 140° C. The reduction is complete and the product consists of a mixture of two isomeric pyrogallites (trihydroxy-cyclohexanes). Phloroglucinol, in aqueous solution, undergoes reduction to phloroglucite under similar conditions.—M. **Godchot** and P. **Brun**: Some derivatives of suberone. The products of reduction of suberone by calcium hydride are described and also the preparation of dibromosuberone.—E. **Grandmougin**: The halogen derivatives of the isatins.—A. **Schoep**: Dewindtite, a new radioactive mineral. This mineral is found mixed with chalcolite in the Belgian Congo. It is a lead phospho-uranate of the composition $4PbO$, $8UO_3$, $3P_2O_5$, $12H_2O$.—C. **Jacob**: The structure of North Annam and Tonkin.—J. **Savornin**: Stratigraphical and tectonic observations at the north-east frontier of Morocco.—J. **Thoulet**: The neutral lines of submarine coast sediments. The agitation of the sea sorts out the minerals of the sea floor and the results are permanent, as the same results are always obtained in the same locality.—A. **Němec** and F. **Duchoň**: A new indicating method for evaluating the vitality of seeds by the biochemical method. The method is based on the assumption that the activity of the catalase present is a measure of the vitality of the seed. The catalase is determined by measuring the amount of oxygen evolved by the action of hydrogen peroxide. A table of results for seeds of various dates between 1891 and 1920 comparing the catalase found with the percentage of germination proves the utility of the process.—MM. **Warcollier** and **Le Moal**: The progressive disappearance of free sulphurous acid in preserved apples.—L. **Mercier**: Contribution to the study of the regression of an organ; the vibrating flight muscles of *Apterina pedestris* during nymphosis.—L. **Roule**: A rare genus of deep-sea Japanese fish, rarely found in the North-African Atlantic Ocean.—T. **Monod**: The morphology of the buccal parts in the male of *Akidognathia halidaii*.—A. **Policard** and G. **Mangenot**: The action of temperature on the cellular chondriome. A physical criterion of mitochondrial formations.—H. **Grenet** and H. **Drouin**: A bismuth compound of the aromatic series and its therapeutic activity. An account of the therapeutic action of a phenol derivative containing bismuth, concerning the preparation and composition of which no details are given. Its antisyphilitic action is comparable with that of the arsenobenzines.

Official Publications Received.

Koninklijk Nederlandsch Meteorologisch Institut. No. 106: Ergebnisse aerologischen Beobachtungen, 8, 1919. Pp. xi+113. No. 108: Seismische Registrierungen in De Bilt, 6, 1918. Pp. xiii+84. (Utrecht: Kemink & Zoon.)

Thirty-fifth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1913–1914. In two parts. Part 1. Pp. 794+xi. (Washington: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1920, No. 30: State Laws relating to Education, enacted in 1918 and 1919. Compiled by Wm. R. Hood. Pp. 231. (Washington: Government Printing Office.)

Agricultural Experiment Station of the Michigan Agricultural College. Chemical Section. Regular Bulletin, No. 291: Fertilizer Analyses. By Andrew J. Patten and others. Pp. 109. (East Lansing, Mich.)

Smithsonian Institution: United States National Museum. Bulletin 100, vol. 4: Contributions to the Biology of the Philippine Archipelago and Adjacent Regions. Foraminifera of the Philippine and Adjacent Seas. By Joseph A. Cushman. Pp. 608+100 plates. (Washington: Government Printing Office.)

Canada. Department of Mines: Geological Survey. Memoir 127. No. 108, Geological Series: Beauceville Map-Area, Quebec. By B. R. MacKay. Pp. iii+105 (including 13 plates). Memoir 128. No. 109, Geological Series: Winnipegosis and Upper Whitemouth River Areas, Manitoba; Pleistocene and Recent Deposits. By W. A. Johnston. Pp. ii+42. (Ottawa.)

Report of the Department of Mines for the Fiscal Year ending March 31, 1921. (Sessional Paper No. 26.) Pp. iii+47. (Ottawa.) 5 cents.

Diary of Societies.

FRIDAY, MARCH 24.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Prof. H. E. Armstrong: The Indigo Situation in India.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Prof. N. Bohr: The Effect of Electric and Magnetic Fields on Spectral Lines (Guthrie Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Capt. R. P. Stanford: Cheap Transport: Heat and Power, with Special Reference to the D. J. Smith Gas Producer.

INSTITUTION OF PRODUCTION ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—E. Fairbrother: Inspection Methods.

JUNIOR INSTITUTION OF ENGINEERS, at 8.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. J. Brownlee and Dr. M. Young: The Epidemiology of Summer Diarrhœa.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. F. G. Donnan: Auxiliary International Languages.

SATURDAY, MARCH 25.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (4).

MONDAY, MARCH 27.

INSTITUTE OF ACTUARIES, at 5.—G. W. Richmond: Austrian National Life Tables.

ROYAL SOCIETY OF ARTS, at 8.—G. Radcliffe: The Constituents of Essential Oils (Cantor Lectures), (2).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—A. Livingston: The Experimental Production of Arthritis.

TUESDAY, MARCH 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. J. W. Evans: Earth Movements (1).

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. Feiling: The Interpretation of Symptoms in Disease of the Central Nervous System (Goulstonian Lectures), (3).

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. O. Heath: The Natural Cure of a Common Cold.—Dr. T. I. Bennett and Dr. Dodds: Observations of Cases involving Disorders of Secretion in the Upper Alimentary Tract.
INSTITUTE OF MARINE ENGINEERS, at 6.30.—E. A. Evans: Petroleum and Lubrication.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. C. Banfield: The Trist Three-colour Exposure Camera.—General Electric Co., and Ilford Ltd.: Two papers dealing with the "Osglim" Lamp and its uses for photographic purposes.
ILLUMINATING ENGINEERING SOCIETY (jointly with the Royal Institute of British Architects) (at Royal Society of Arts), at 8.—Discussion on The Lighting of Public Buildings; Scientific Methods and Architectural Requirements. (*a*) An Account of Experimental Work and Results, presented by Dr. E. H. Rayner, J. W. T. Walsh, and H. Buckley. (*b*) Some examples of the Lighting of Decorative Interiors.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—H. J. E. Peake: Bronze Swords and the Aryan Problem.

WEDNESDAY, MARCH 29.

PREHISTORIC SOCIETY OF EAST ANGLIA (Annual London Meeting) (at Society of Antiquaries), at 2.15.—O. G. Crawford and H. J. E. Peake: A Flint Factory at Newbury Sewerage Outfall Works, Thatcham, Berks.—Miss Nina F. Layard: Presidential Address: Prehistoric Cooking Places in Norfolk, with a brief account of Heating Stones, their History and Significance.—L. A. Armstrong: Further Discoveries of Engraved Flints and Implements at Grimes' Graves.—Dr. A. Smith Woodward: Description of the Rhodesian Skull.—E. J. Wayland: Palæolithic Types of Implements in relation to the Pleistocene Deposits of Uganda.
INDUSTRIAL LEAGUE AND COUNCIL (at Caxton Hall), at 7.30.—Major I. Salmon: The Necessity for Educating the Worker in Industrial Economics.
ROYAL SOCIETY OF ARTS, at 8.—Sir Thomas Oliver: Alcohol in Relation to Industrial Hygiene (Shaw Lecture).

THURSDAY, MARCH 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. M. Hind: Landscape Etchers: New and Old (1).
CHEMICAL SOCIETY (Annual General Meeting), at 4.30.—Sir James Walker: Presidential Address. At 8—Informal Meeting.
ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Prof. H. E. Roaf: The Acidity of Muscle during maintained Contraction.—The late Dr. W. G. Ridewood: Observations on the Skull in foetal specimens of Whales of the Genera *Megaptera* and *Balaenoptera*.—Dr. W. L. Balls: Further Observations on Cell-Wall Structure as seen in Cotton Hairs.—L. T. Hogben and F. R. Winton: The Pigmentary Effector System. I. Reaction of Frog's Melanophores to Pituitary Extracts.—Dr. Agnes Arber: The Development and Morphology of the Leaves of Palms.
NEWCOMEN SOCIETY (at Institute of Marine Engineers), at 5.—Eng.-Comdr. E. C. Smith: The Centenary of Naval Engineering: A Review of the Early History of our Steam Navy.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. H. Mackenzie: Diseases of the Thyroid Gland (Lumleian Lectures), (1).
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Capt. G. de Havilland: Design of a Commercial Aeroplane.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—R. B. Matthews: Applications of Electricity to Agriculture.
ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—K. M. Walker: Renal Infections, with an account of experimental work on the ascending route.

FRIDAY, MARCH 31.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Dr. W. L. Balls: Advantages and Defects of Team Work in Economic Biology.—Dr. F. Kidd: Problems of Fruit Storage.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. H. H. Jeffcott: The Milling of Screws, and other Problems in the Theory of Screw-threads.
INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—J. S. Highfield: Presidential Address.
JUNIOR INSTITUTION OF ENGINEERS, at 8.—D. P. Dickinson: The Steel Melting Shop.

SATURDAY, APRIL 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (5).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

FRIDAY, MARCH 24.

METEOROLOGICAL OFFICE (South Kensington), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (10).
KING'S COLLEGE, at 5.30.—Dr. G. Cook: Some Recent Advances in our Knowledge of the Strength of Materials.

SATURDAY, MARCH 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: Science and the Food we Eat.

MONDAY, MARCH 27.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. P. Duval: Données actuelles de la chirurgie intra-thoracique.

TUESDAY, MARCH 28.

UNIVERSITY COLLEGE, at 5.30.—Col. W. M. St. G. Kirke: Imperial Defence as affected by the War (3).

WEDNESDAY, MARCH 29.

HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (10).

THURSDAY, MARCH 30.

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. L. D. Barnett: The Hindu Culture of India (5).
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. E. Stilgoe: Water (2), Its Distribution and Use (Chadwick Public Lectures).

SATURDAY, APRIL 1.

POLYTECHNIC (Regent Street, W.1), at 10.30 A.M.—Prof. H. E. Armstrong: The Wonders and Problems of Food.
HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. W. A. Cunnington: Woman's Sphere in Savage Africa.

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SATURDAY, APRIL 1, 1922.

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Science at the Post Office.

AFFAIRS relating to the technical services under the Post Office have in the past few years been greatly in prominence; indeed, this has been the case since a Select Committee of the House of Commons began in 1912 to investigate the original contract in connection with the Post Office scheme for an Imperial Wireless Chain. The manner and method adopted by the Post Office in handling this scheme have in many ways proved most unfortunate for the State.

More recently, the serious and widespread complaints of the public concerning the quality of the Post Office telephone service led, in the early part of last year, to the appointment of a Select Committee to inquire generally into the situation; the Committee met forthwith and took much evidence from the officials of the Department and also from witnesses representing various public bodies. This evidence was reported to the House of Commons in June last (Report from the Select Committee on the Telephone Service. H.C. 191 of Session 1921): within the past few days the Committee has submitted its recommendations to Parliament, wherein a radical reorganisation of the Post Office is proposed (Report from the Select Committee on the Telephone Service, 1922 [No. 54]).

Since the Select Committee (of 1921) was appointed, particularly by reason of the allegations made by telephone users regarding the inefficiency of the service provided for them—a matter obviously closely connected with the question of the technical qualifications of the engineering staff employed thereon—it follows that those portions of the evidence given before the Select Committee, which deal with the methods adopted by the Post Office in recruiting its staff, are of considerable importance from the point of view of the reforms which should be taken in hand. Among the witnesses appearing before the Committee who dealt with this subject were the present engineer-in-chief and a former engineer-in-chief to the Post Office. The present engineer-in-chief in his evidence indicated the policy the Department is now adopting in the matter of recruiting its engineers, whilst the former engineer-in-chief, who gave evidence on behalf of the London Chamber of Commerce, contrasted the standard in the qualifications accepted by the Post Office from its engineers with that demanded in similar circumstances by the telegraph and telephone authorities in America and in Europe: the comparison tells greatly to the disadvantage of the authorities at St. Martin's-le-Grand. It was pointed out by the latter witness that whereas, from early times, telegraph and telephone administrations in foreign countries have exercised great care in appointing to the engineering grades leading to the superior positions in the technical branch of their undertakings candidates who have a high standard of technical qualifications, on the other hand, in the British Post Office, subordinate officials, who were not properly qualified, have, in many cases, been promoted into responsible positions.

The condition of affairs in relation to the engineering staff of the Post Office, to which allusion was made by the former engineer-in-chief in his evidence, was in no way in the nature of the giving away of official secrets: the unsatisfactory state of affairs prevailing on the staff side of the engineering department of the Post Office has already been brought to public notice by the Select Committee appointed in April 1912, to inquire into the wages and employment of Post Office Servants. This Committee, in dealing with the Engineering Department, reported:

"That it is proposed to recruit the class of Assistant Engineers by competitive examination, one half of the vacancies being offered to Post Office Servants up to the age of 40 in the case of those who have engineering experience, including junior engineers, and 32 in the case of those who have not, and the other half to outside candidates of not more than 24 years of age who have had two years' training in a technical college or in works. . . .

"That the work has become more technical, more complicated and more difficult, and that the age limit of 32 ought rather to be lowered than abolished.

"That there is no justification for reserving a proportion of the vacancies in the Assistant Engineers' Class for clerks in the Engineer-in-Chief's Office.

"That it is undesirable to limit the field of recruitment for the class of Assistant Engineers to those within the Department, and that it is important that 50 per cent. of the vacancies should be filled by young men of wider education and higher engineering attainments than are usual among Post Office Servants." (Report from the Select Committee on Post Office

Servants (Wages and Employment). No. 268. 1913. See para. 776.)

Although, as the above extract from the Select Committee's Report shows, it was tacitly admitted by the officials who gave evidence that the need existed for recruiting for the Post Office service men of wider education than those already serving, nevertheless a scheme, introduced in 1907, for recruiting twenty-five per cent. of engineers by open competition has been allowed to remain in abeyance from 1911 until the present time. Now that engineering vacancies are again to be filled by open competition from among candidates who have received an adequate education, twenty per cent. only of the engineers required for the telegraph and telephone services are apparently to be recruited in this way, whilst the remaining eighty per cent. of these positions are to be reserved for the subordinate grades serving in the Department, in order to fill these as heretofore by internal promotion.

In the matter of recruiting their engineering staff, the attitude of the British Post Office has been widely different from that of the telegraph and telephone administrations in other parts of the world. In the early days of telegraphy, when the specialised technical education needed by the telegraph engineer was not provided in the then existing schools, the telegraph administration itself, in many cases, arranged for appropriate courses to be given under its own auspices, as for example the courses at the East Indian Engineering College, Cooper's Hill; at the École Supérieure des Télégraphes, Paris; at the Istituto superiore, Rome; at the State Telegraph School, Stockholm; at the Versuchsamt, Berlin; etc. Now that instruction of a suitable kind is available in the technical high schools and universities abroad, foreign telegraph and telephone administrations, in practically every part of the world, recruit their engineers from amongst men who hold a diploma in civil or mining engineering as well as some recognised certificate in electrical engineering, or a diploma in electrical engineering; and, in some cases, where suitable courses are provided at universities, as in Belgium, Bavaria, Germany, etc., candidates for the higher career on the technical side are required to possess either a suitable degree or to hold a recognised diploma of equivalent standard.

Quite apart from the fact that the telegraph and telephone services cannot be carried on satisfactorily in this country by engineers possessing a lower standard of qualifications than that demanded from men occupying similar positions in foreign countries, it is exceedingly important on other grounds that the recruitment of engineers for the Post Office engineering department shall, now that a complete re-organisation of the Department is recommended by a Select Committee, be placed upon a sound basis. How important the other grounds are will readily be apparent if the estimates presented to Parliament last year be scanned through, for it will be found that the "establishment" of Post Office engineers is in this document shown to be above 570.

A further matter which, in view of the complicated nature of the engineering work undertaken by the Post Office and of the responsibilities of those in high positions, requires early attention is the status and method of selection of the chief of the Post Office engineering department and his immediate assistants. From every point of view, it is imperative that the officials holding these positions should be men of eminence in the engineering profession. Strong reasons exist at the present time for throwing open these appointments to the engineering profession generally. The adoption of such a course would present no difficulties, nor would it be exceptional: the appointment of the head of a department has at all times been recognised as being one which may be filled by a candidate from outside the Department. Many precedents exist in the Civil Service for the bringing in of a person from the outside to fill vacancies in high positions: for example, in the Post Office itself, during the past twenty-five years, four of the five men who have held the chief administrative position, that of secretary, and one of the engineers-in-chief have been persons who began their careers and spent many years outside the Department. It cannot be questioned that the chief technical adviser in an undertaking of the magnitude and complexity of the Post Office telegraph and telephone department requires to be a man of professional attainments of as high an order as is the administrative chief whose colleague he is to be.

No difficulty need be experienced by the Postmaster General in making a suitable selection of a technical adviser from an open field of candidates, if he will but call in the assistance of an *ad hoc* committee or board to advise him as to the merits of the several candidates; such a committee or board might, for his purposes, consist of the presidents of the Royal Society, the Institution of Civil Engineers and the Institution of Electrical Engineers. It has for some time been widely felt that such a method of filling the chief positions in government departments has become generally necessary in order to meet the present-day conditions. So far as the Post Office is concerned, in view of the announcements which have appeared that the present engineer-in-chief will be vacating his position in May next, the matter has become pressing. The adoption of the procedure indicated by the Postmaster General, when filling this vacancy, would meet with very general approval and give considerable satisfaction in the country.

The Imperial Institute.

It is astonishing that, at a time when the Imperial Institute is looking forward to further developments in its work, a proposal should be put forward involving the dismantling of more than half of the recently extended and improved collections in the Public Exhibition Galleries of the Institute—without question the finest illustration of economic geography in the world—in order to make room for the war relics known as the Imperial War Museum at present housed in the Crystal Palace. The *Times* of March 7 contains leading and special articles on the subject in which a clear case is made for the abandonment of the proposal. Attention is directed to the resolution of protest recently passed by the Executive Council of the Institute. While appreciating the desire for economy in housing the War Museum, the council considers that this object should be achieved by some other method than by a plan which would be seriously detrimental to the development of the educational and commercial work for which the Imperial Institute was erected and endowed. Resolutions of protest have also been received by the council from a number of important bodies, including the Association of British Chambers of Commerce; the Chambers of Commerce of Liverpool, Manchester, Glasgow, and Bristol; the Royal Institute of British Architects; the Timber Trade Federation; the Institute of Builders; and the Silk Association.

For a quarter of a century the Imperial Institute with very slender means has been carrying on work of great service to the Empire, a fact far too little known and appreciated. The reward of such endeavour should be the provision of better facilities for development, and it is precisely in this respect that the proposals now put forward on behalf of the War Museum would be so detrimental in their effects. The Imperial Institute is becoming the recognised headquarters of organised effort in this country for the development of knowledge of the natural resources of the overseas countries of the Empire, and it is to be hoped that the Government will see that nothing of the character of the proposals justly condemned by the *Times* shall prevent the achievement of so desirable a purpose.

A Treatise on Petroleum.

Petroleum. By Sir Boverton Redwood. Fourth edition, reset throughout. In three Volumes: Vol. 1, pp. xxx+364+pl. 16. Vol. 2, pp. iv+365-740+pl. 17-31. Vol. 3, pp. iv+741-1353. (London: C. Griffin & Co., Ltd., 1922.) £5, 5*s*. net.

In a review of the first edition of this work, published in Nature in December 1896 (vol. 55, p. 169), it was asserted that "to write, or to compile a comprehensive text-book on petroleum, demands an acquaintance with dissimilar subjects and varying walks of life, very rarely centred in one individual. The present work is and will ever remain remarkable as the production of a man whose scientific attainments, and whose relation to the petroleum industries, were such that he, probably better than any other living man, was fitted to undertake the task."

During the quarter of a century that has since elapsed the "dissimilar" sciences that form the foundation of petroleum technology have both widened and deepened; chemical research has extended our knowledge of the constitution of the hydrocarbons that form mineral oil; the newly developed branch of colloidal chemistry, in its bearing on the properties of argillaceous substances, has affected the methods of refining and thrown new light on the problems of crude-oil migration underground; the discovery of new occurrences and, especially, the compilation of data obtained from established fields have put a new complexion on the questions of oil geology; improvements in mechanical engineering have modified the methods of exploitation and transport; whilst the remarkable development in the use of internal combustion engines, inspired by stern necessity during the war, has been accompanied by an extension of the theoretical and practical aspects of oil as a source of power. In complexity and volume each of these phases of the natural history of oil and the technique of its uses is to-day comparable to the whole range of petroleum technology as it was when Sir Boverton Redwood first attempted the task of summarising the disconnected and apparently unrelated data of the petroleum industry.

To keep in touch with these developments was perhaps possible to the author if to no one else; to keep abreast of them he frankly recognised as impossible, and thus we find in this new edition of a work which "is and will ever remain remarkable" the results of the friendly co-operation of more than two dozen specialists. The contributory work of these friends is evidence of their belief in the value of this treatise as a work of reference, and is at the same time a sign of the magnetic personality of the author and the affectionate respect with which he was regarded among all classes of workers in the oil world. But the thorough revision of some parts in this way serves to bring into relief others which remain as they were issued with the third edition in 1913. The book in this respect bears the marks of the war, during which the author's unremitting devotion to honorary public service left him insufficient time for his accustomed methodical compilation of new facts and for the judicial examination of new theories. To specialists in the accessory sciences and to local workers in distant fields, who will necessarily subject appropriate

chapters to microscopic analysis, the deficiencies thus left will be obvious; to those who knew the author personally, and were thus able to estimate the heavy burdens which were laid on him during the anxious years 1914–18, these blemishes will be regarded as veritable war wounds.

Thus, this fourth edition of a recognised standard work, even with its blemishes, will be to workers in the oil world an appropriate memorial to its author. In most chapters there are the results of his characteristically painstaking assembly of data; the constant sense of relativity shown in their summary; the judicial instinct with which conflicting theories are balanced; the conscientious recognition of the work of others; the cautious estimates of "prospects" likely to affect commercial interests; the record of observations privately obtained from innumerable friends; and, finally, the signs of war weariness which probably brought about the fatal illness to which he succumbed only two days after passing for press the complicated section on shale oil and allied industries.

The publication of this edition marks a definite stage in the history of petroleum technology; in complexity its ramifications have now passed beyond the comprehension of any one individual; no single person can hope to prepare the fifth edition of Redwood's "Treatise." Its author has passed away, but his spirit remains incarnated in the Institution of Petroleum Technologists which he founded just before the war, and that body might well regard as its chief mission the maintenance up to date of this its bible as a standard work of reference. The Institution has already in the press a volume summarising recent developments in special branches of the petroleum industry, and this work, supplemented by Mr. Dalton's revised and extended bibliography, will bridge many of the gaps left in the Treatise by Sir Boverton Redwood's unexpectedly sudden death.

T. H. HOLLAND.

Entropy as a Tangible Conception.

Entropy as a Tangible Conception: An Elementary Treatise on the Physical Aspects of Heat, Entropy, and Thermal Inertia for Designers, Students, and Engineers, and particularly for Users of Steam and Steam Charts. By Eng. Lt.-Commr. S. G. Wheeler. Pp. 76. (London: Crosby Lockwood and Son, 1921.) 8*s*. 6*d*. net.

OPINIONS will differ as to the merits of the title which Lt.-Commr. Wheeler has chosen for this volume. The extreme relativist, who regards the notion of force derived from our muscular sensations as a relic of animism, will no doubt condemn it. "To-day we have dispossessed the demons, but the *ghost of a muscular pull* still holds the planets in place."[1] On the other hand, the student of either physics or engineering will welcome any suggestion which assists him in understanding the nature of the "ghostly quantity," entropy. "The more shadowy the conception to be visualised, the greater the need of a definite material analogy." The quotation is from the instructive presidential address to the Physical Society of London delivered by Prof. Callendar in 1911. Here it is pointed out that the caloric theory is perfectly consistent with Carnot's principle and with the mechanical theory for all reversible processes. The quantity measured in an ordinary calorimetric experiment is the motive power or energy of the caloric, and not the caloric itself. Prof. Callendar identifies caloric with the "thermodynamic function" of Rankine, or the "entropy" of Clausius.

With this address and with the important paper by Sir J. Larmor "On the Nature of Heat" (Proc. Roy. Soc. vol. 94, p. 326, 1918) we imagine Lt.-Commr. Wheeler is not acquainted. He sets out to give a more tangible interpretation of entropy than that afforded by Boltzmann's statement that it is "the logarithm of the probability of a complexion." This he endeavours to do, and in our opinion with considerable success, by means of mechanical analogies. There is, needless to say, nothing novel in such an attempt. Poynting and Thomson, in their text-book on "Heat," direct attention to quantities which are analogous to entropy; indeed, we may, according to Prof. Callendar, go back to "the old picturesque phraseology of the material fluid, implied in Carnot's waterfall." Just as gravitational energy may be regarded as the product of mass and the height of the mass above zero level, so heat energy may be regarded as the product of "thermal inertia" and temperature. Thus entropy, being, as Swinburne called it, "the measure of the incurred waste," may be interpreted as "incurred thermal inertia." But in this book a distinct point, which we had not previously met with in print, is made by considering, not linear, but rotational, motion, so that thermal inertia corresponds to the moment of inertia, mk^2, of a rotating system. Here we have a case where the rotational inertia is capable of variation through changes in the value of k, the radius of gyration.

This may be illustrated by suspending a flat, circular disc from a point in its circumference by a thin wire by means of which it can be spun round around a vertical axis (Fig. 1). At first the disc will rotate about its original vertical diameter, but on the attainment of a certain speed the disc will start to

[1] Dr. Mott-Smith, in J. M. Bird's "Relativity and Gravitation." (Methuen, 1921.)

rise, the wire now making an angle with the vertical whilst the disc rotates about an axis through its centre and perpendicular to its plane, the centre remaining vertically below the fixed point of suspension. At a still higher speed the disc will begin to whirl about the point of suspension with the wire and its own plane both practically horizontal. "The changes in inertia of the rotating disc occur at definite speeds as it receives energy, and it is not so improbable as at first sight it may seem, therefore, that the changes in form which occur at perfectly definite temperatures (as, for instance, when heat is added to ice to turn it to water, and to water to turn it to steam) may really take place in a similar manner by some corresponding change in disposition in the particular internal or ionic movement which we imagine to constitute heat; in other words, that this motion may enjoy some form of increased freedom which may be regarded as an increase of thermal inertia."

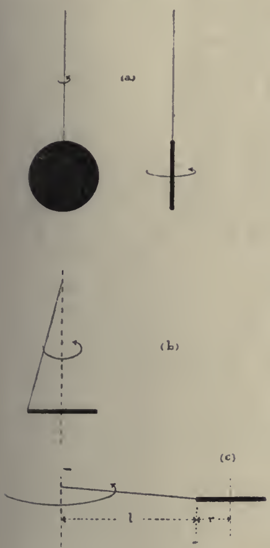

FIG. 1.—An instance of change in rotational inertia.

The conception of entropy as incurred thermal inertia is worked out in detail in the later chapters, and an interesting mechanism is described which affords a parallel to the behaviour of the working substance in an engine (Fig. 2). In this model the actual working substance is represented by an arrangement consisting of a short shaft carrying a pair of heavy "governor" balls mounted on bell-crank levers controlled by varying tension springs. Changes in the rotational inertia of the revolving masses represent changes in the thermal inertia of the working substance. With the apparatus illustrated in the book it is possible to go through a cycle of operations, such as the usual steam-engine cycle (Rankine's cycle) or Carnot's cycle, and examine the analogies between thermal and mechanical processes in detail. Teachers and students of thermodynamics would be well advised to study this volume.

In connection with such mechanical analogies our attention has been directed to an address delivered before the Institution of Civil Engineers in 1883 by Prof. Osborne Reynolds. The lecturer referred to the work of Rankine, who assumed the thermal motion to be rotatory, and, when compelled to abandon the theory of "molecular vortices," called on all those who taught the subject of thermodynamics to try to find some popular means of illustrating the second law. "The call was made twenty years ago; but I believe up to the present no such illustration has been forthcoming." "The communication of heat to matter means the communication of internal agitation—mob agitation. If, then, we are to make a machine to act the part of hot matter, we must make a machine to perform its work in virtue of internal promiscuous motion amongst its parts." As an illustration, Osborne Reynolds instances the possibility of raising a bucket by violently shaking the upper end of a heavy rope or chain. A modification of the illustration is afforded by a kind of chain composed of a series of parallel horizontal bars of wood connected and suspended by two strings. "By giving a circular oscillation to the upper bar, the whole apparatus is set into a twisting motion (agitation); the strings are continually bent, and the vertical length of the whole system is shortened." Osborne Reynolds refers also to the governor of a steam-engine, which acts by kinetic elasticity depending on the speed. "The motion of the governor is not of the form of promiscuous agitation, but, though systematic, all the motion is at right angles

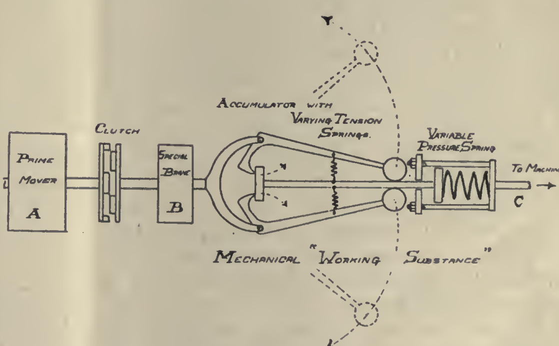

FIG. 2.—Mechanism illustrating the behaviour of the working substance in an engine.

to the direction of operation, so that the principle of its action is the same." Here we have the germ of the model discussed in the book under review. We may venture the opinion that the development of this model owes not a little to the late Prof. A. M.

Worthington, whose name, however, is nowhere mentioned. "These kinetic examples of the action of heat must not be expected to simplify the theory, except in so far as they give the mind something definite to grasp; what they do is to substitute something we can see for what we can barely conceive."

The Mass Formula of Cathode-ray Corpuscles.

Vérification expérimentale de la formule de Lorentz-Einstein. Par Prof. Ch.-Eug. Guye, en collaboration successive avec S. Ratnowsky et Ch. Lavanchy. (Mémoires de la Société de Physique et d'Histoire naturelle de Genève, vol. 39, fasc. 6.) Pp. 273–364 + plates 4–6. (Genève: Muséum d'Histoire naturelle, 1921.) 20 francs.

THIS memoir gives a detailed account of experiments made by MM. Guye and Ratnowsky in 1907–9, and by MM. Guye and Lavanchy in 1911–13, with the object of testing the mass-formulæ of Abraham and of Lorentz for the cathode-ray corpuscles. Preliminary notices of these researches have appeared from time to time, but now they are published in their final form, preceded by a theoretical and historical introduction of twenty pages, whilst twenty pages are devoted to the experiments of Guye and Ratnowsky, and forty pages to those of Guye and Lavanchy; the whole concludes with a small collection of tables and plates. There are records of twenty-seven experiments by Guye and Ratnowsky for the range from $\beta = 0{\cdot}21$ to $\beta = 0{\cdot}59$, and of 151 experiments by Guye and Lavanchy from $\beta = 0{\cdot}25$ to $\beta = 0{\cdot}49$. The first series of experiments gives for the excess of the observed mass of the electron above the Lorentz mass a mean value of five thousandths, and for that above the Abraham mass a mean value of nineteen thousandths, with a probable error of about three thousandths; the second gives for the same quantities two ten-thousandths, eleven thousandths, and one two-thousandth respectively. Thus the evidence of these investigations is strongly in favour of the Lorentz mass formula, in complete agreement with previous researches of similar rank, such as those of Bucherer, Wolz, and Neumann on β-rays, and of Hupka on accelerated photo-electrons.

Like Hupka, Guye and his associates used a relative method; the electric or magnetic force, as the case happened to be, which was required in order to produce a prescribed deflection of a given fast cathode-ray pencil, was compared with that needed to produce an equal deflection of a slow cathode-ray pencil selected as a standard. But whilst Hupka used only the magnetic deflection and relied for the determination of the speed of his photo-electrons on the measurement of the vacuum tube potential employed in accelerating them, Guye and his associates used both the electrostatic and magnetic deflections, not simultaneously, as had been the usual previous practice, but separately and alternately. Thus they eliminated errors due to variations in the state of the vacuum tube, rejecting *ab initio* all experiments in which sudden changes in its condition were suspected. They avoided the large errors which are almost inseparable from the measurement of very high potentials (of the order of 80,000 volts), which completely vitiated Hupka's results, at any rate according to Heil's criticism of his experiments.

The relative method, or method of "identical trajectories," as Guye and his associates call it, has the advantage of not requiring an exact knowledge of the distribution of the electric and magnetic forces, which, especially for the electric field, is very difficult to determine with sufficient accuracy. Since the speed of an electron is not altered by a magnetic field, we can for two cathode-ray pencils of different speeds make the terminal deflections equal by a proper choice of the ratio of the magnetic forces at corresponding points, and so ensure that the trajectories are identical throughout; then the electro-magnetic momenta (transverse mass × speed) will be in the ratio of the magnetic forces—*i.e.* of the electric currents generating the field. But for the electric field the equality of the terminal deflections of two cathode-ray pencils of widely different speeds does not guarantee the identity of their trajectories, if only because the electric field generally alters the speed. In the experiments of Guye and his associates the changes of speed produced amounted to only a few thousandths of the whole, so that the trajectories were very nearly identical, and the error arising from this cause was negligible. Consequently for two cathode-ray pencils of widely different speeds undergoing equal electrostatic deflections the products of their transverse masses into the squares of their speeds could be taken to be in the ratio of the deflecting electric forces—*i.e.* of the differences of the potential between the plates of the condenser used to produce the deflection. Thus the ratios of the speeds and of the transverse masses of the two cathode-ray pencils could be expressed in terms of the measured ratios of the currents in the magnetising coils and the potential differences of the condenser. In this way the speeds and masses of a number of cathode-ray pencils of various high speeds were compared with those of a pencil of a standard low speed, without the need of finding the distribution of the electric or magnetic fields or the discharge potentials for the high-speed pencils.

In order to test the mass formulæ the speed and mass of the slow-speed pencil were found by measuring the discharge potential directly with an electrometer, which could be effected with sufficient accuracy, because in this case the difference of potential was only about 14,000 volts. The speed ($\beta = 0{\cdot}228$) was calculated by successive approximation, the appropriate mass formula being employed to estimate the necessary correction to the zero mass, which for this low speed amounted to only 3 per cent. The result, together with the measured electrostatic deflection, supplied the data needed for the evaluation of the electric field integral, which was used in the comparison with the high-speed cathode-ray pencils. In the earlier experiments this field integral was also evaluated by graphic calculation from the constants of the condenser, but the experimental method of determination was adopted finally as more accurate, the difference between the two methods being about 5 per cent. In the later experiments curved condenser plates were used, in order to render the trajectories more nearly equipotential; in this case graphic calculation was impossible. No data are given for the magnetic field integral, perhaps because it was always eliminated; nevertheless, its evaluation from the constants of the apparatus might have been useful as a check, and would have made the direct calculation of the magnetic deflection possible, with a view to meeting beforehand Heil's objection to Hupka's use of the relative method, viz. that the observed magnetic deflections differed widely from those calculated from the measured currents and the constants of the apparatus.

Apart from the absence of this check, every precaution seems to have been taken to ensure accuracy; the earth's magnetic field was compensated, electrostatic influences were guarded against, special arrangements were used to secure regular working of the vacuum tube, and the number of observations was amply sufficient to eliminate practically all accidental errors. The authors are to be congratulated on producing a most valuable contribution to our knowledge of the dynamics of the electron.

British University Problems.

Second Congress of the Universities of the Empire, 1921: *Report of Proceedings*. Edited by Dr. Alex. Hill. Pp. liv+452. (London: Published for the Universities Bureau of the British Empire by G. Bell and Sons, Ltd., 1921.) 21*s*. net.

THE Report of the Proceedings of the Second Congress of the Universities of the Empire held at Oxford on July 5–8, 1921, has just been published as a volume of more than five hundred pages. It will be recalled that the first of these Congresses was held in 1912, and, but for the intervention of the war, would have been followed by the second in 1917. Fifty-nine universities—six more than in 1912—sent upwards of three hundred delegates and representatives to it. The main topics under discussion were the balance of studies; the teaching of civics, politics, and social economics; secondary education; adult education; technological education; the training for commerce, industry, and administration; the training of school teachers; finance; research; and the interchange of teachers and students—all, of course, with reference to the universities. Such a varied and comprehensive programme required some skill in arranging and handling, and Dr. Hill is to be congratulated on the way he has edited the Report.

Thirty-five papers were presented to the Congress. These have been printed *in extenso*, together with verbatim records of the discussions which followed. Though lack of space prevents it, a mere list of the names of the various speakers would be interesting in itself, as giving a list of distinguished scholars drawn from all quarters of the British Empire. For such particulars, reference must be made to the Report itself. The opening address was given by Lord Curzon, the Chancellor of the University of Oxford, who welcomed the Congress to Oxford, and expressed his opinion of the value of such Congresses as having it in their "power to play a very important part in developing the organisation and drawing closer the bonds of the British Empire." This was followed by an able paper on "The Present and the Future of Hellenism." Unfortunately, the discussion was limited, no doubt, by the fact that it was followed by four other papers in immediate succession. Sir A. J. Balfour, the Chancellor of the Universities of Cambridge and Edinburgh, who presided at the discussion on "The Universities and the Teaching of Civics, Politics, and Social Economics," in his opening speech raised the question of innate differences of races among human beings, but decided, very wisely, not "to wander into a topic so tremendous." In the general discussion, the point that "only a few boys in any school can go to the university" was raised, and, curiously enough, was emphasised in a paper which followed dealing with the question of the university and secondary education. The same point came up in another form, when Lord Haldane, in a notable address on adult education, referred to the extent to which the universities were dependent on the taxes and rates. "Democracy," he said, "is beginning to ask why it is that, while they pay the rates and taxes, only a limited section of society gets

the benefit." A most interesting discussion followed the six papers dealing with various aspects of this subject.

On the subject of technological education, four papers were contributed. Lord Crewe deprecated "the intellectual vulgarity that sets the scholar in a different class from the workers, either for laudation or contempt." In the discussion, reference was made to the "great misfortune" of segregating students of technology in separate "technological universities," and so preventing them from mixing with the students of other faculties, to their mutual loss. In the debate on "The Universities and the Training of School Teachers" a similar note was struck, several speakers emphasising the necessity of a university atmosphere for such training.

Sir Robert Stout, Chancellor of the University of New Zealand, in opening the meeting on "University Finance," gave an interesting account of educational finance in New Zealand. The discussion, *inter alia*, brought into relief the different attitudes of the over-seas universities and the home universities to the question of State aid and university autonomy. One of the most important, and certainly one of the most interesting, discussions took place on the subject of "Research." Lord Robert Cecil, in summing up the debate, made it quite clear that at present research in the universities is mainly obstructed by "want of money and want of leisure." In this we may well agree. In the last session, the case for the institution of a Sabbatical year for the professoriate was well argued, but obviously "want of money" is the rock upon which such a scheme will founder. Sympathetic references which were made to the death of Lord Balfour of Burleigh, who should have presided at the discussion on "The Training for Commerce, Industry, and Administration," are duly recorded.

The Report gives a full account of a most instructive congress, and the papers and discussions bristle with points which in recent years have been giving rise to much thinking in university circles. Any one interested in higher education cannot fail to profit by reading it.

India as a Centre of Anthropological Inquiry.

Principles and Methods of Physical Anthropology. By Rai Bahadur Sarat Chandra Roy. (Patna University Readership Lectures, 1920.) Pp. xiii + 181. (Patna: Government Printing Office, 1920.) 5 rupees.

THERE is not an anthropologist in Europe who will not extend a welcome to this work by Rai Bahadur Sarat Chandra Roy, reader in anthropology at Patna University, not only for what it is, but also for what its appearance signifies. Anthropology, hitherto a plant of exotic growth in India, has at length taken root in the native mind. A single readership in a single university is a somewhat slender root for a plant which has to cover more than 300 millions of people, but those who have noted the series of excellent researches and monographs which have been published in recent years by Mr. Roy and by his colleagues and disciples will have no fear of the result if a fostering hand be extended by the Government of India. Our knowledge of the peoples of India has been laid by those great-minded Civil Servants who realised that good government must be based on accurate, intimate, and sympathetic records of the mentality, customs, and traditions of the governed. It was at the feet of one of these great Indian servants, Sir Edward Gait, now chancellor of Patna University, that Mr. Roy was introduced to the methods and aims of modern anthropology.

The book under review, "Principles and Methods of Physical Anthropology," is based on the first course of lectures given by Mr. Roy as reader in anthropology in Patna University. The lectures now published, six in number, form one of the best introductions to the study of anthropology in the English language. It is true that many minor statements require emendation or qualification, but we are surprised that one who has made his reputation as a cultural anthropologist should have grasped so accurately the methods, aims, and theories of those who study the evolution of the human body and brain, as well as the rise and spread of modern races of mankind.

A mere enumeration of the titles given to the six lectures or sections into which this book is divided will show the scope of the author's work. The first is devoted to the evidence relating to man's place in the zoological scale; the second to the evidence relating to man's antiquity; the third to the theory of evolution; the fourth to the theory of evolution applied to man's body, brain, and culture; the fifth to man's first home and early migrations; the sixth to the evolution of human races and their classification. Thereafter follow appendices giving the chief schemes for classification of human races, bibliographies, etc.

Hitherto the problems of anthropology have been viewed solely through European eyes; it is well that they should be seen also from the point of view of those who live on the banks of the Ganges. Certain it is that India is nearer the hub of the anthropological universe than Western Europe. Many anthropologists in looking round the world for the most likely place to serve as a cradle land of mankind have selected India or some neighbouring region—a belief in which Mr.

Roy has faith. But whether this be so or not there can be no doubt that India lies on the great racial divide of modern mankind. Within its population taper off the three great divisions into which human races are grouped—the white, yellow, and black. Here, too, three great linguistic families come into juxtaposition. It is a vast treasure-house of ancient rites, beliefs, and customs.

It is a great task to which the author of this work has set his hand. He is bold enough to hope that his school will do for the 300 millions of India what the anthropological schools of Cambridge and Oxford have done for the 36 millions of England. The English pioneers had an uphill fight, and it is the memory of this experience which will make them extend a willing and helping hand to Rai Bahadur Sarat Chandra Roy, reader in anthropology in Patna University, in the difficulties and apathy which now confront him and his school.

Arthur Keith.

Our Bookshelf.

University of London. Galton Laboratory for National Eugenics: Eugenics Laboratory Memoirs, VII. On the Relationship of Condition of the Teeth in Children to Factors of Health and Home Environment. By E. C. Rhodes. Pp. viii + 80. (London: Cambridge University Press, 1921.) 9*s.* net.

Mr. Rhodes has analysed the records of five School Medical inspectors charged with the examination of the school children of an administrative county, with a view of discovering whether relationship could be traced between condition of teeth and factors of health and home environment. The bulk of the paper is devoted to an investigation of methods of standardisation, *i.e.* to the solution of a problem of the following kind: given that two observers having different standards of classification examine and group into classes random samples of the same population, required, the corrections of the several distributions needed to render the results comparable. Two methods of solution, involving different assumptions, are employed. It is shown that the individual variations of standard are very large and that, for purposes of correlation, it is necessary to deal separately with each inspector's data. Actually very little correlation was found between the state of caries in the teeth of children aged 12-14 and either general health or home environment.

Both the author and Prof. Karl Pearson, in an introductory note, emphasise the need of standardisation. The results of this inquiry justify the following remark of Prof. Pearson: "There are many urgent practical problems which could be adequately solved by a study of the child population of this country, but they can only be solved by the leisurely laboratory method of observation, by standardised judgments and an efficient training in modern statistical methods. At present the observations are too rapid to be of great scientific value, the judgments are personal opinions rather than real measures of fact, and the statistical methods of school officers' reports rarely indicate a knowledge extending beyond the elementary rules of arithmetic. These results are not due to any fault of the medical officers themselves, but to the inadequate system under which they are trained for their work, and to the speed under which they are compelled to form their record."

Mr. Rhodes' paper, despite the necessarily negative character of his main conclusions, is a valuable piece of work and enforces lessons which the public, not excluding medical officers, are slow to learn.

Hellenism and Christianity. By Edwyn Bevan. Pp. 275. (London: George Allen and Unwin, Ltd., 1921.) 12*s.* 6*d.* net.

With the exception of two essays on "Bacchylides" and on "The Greek Anthology," all the essays in this volume deal with some aspect or other of the relationship of Christianity to the world, ancient or modern. Touching the ancient world, there are two essays on the earliest contacts of Christianity and Paganism, and two especially delightful ones on St. Augustine. The essays on the modern world all revolve around the conflict between our "rationalistic" civilisation and religious experience as focussed by the life and teaching of Christ. The author's limpid style makes it a pure pleasure to read his arguments, and his complete candour should secure for them respectful consideration even from those who stand intellectually aloof from theology. A good example of his method, on a non-controversial topic, is the short essay on "Dirt," in which he works out in a most interesting way the polarity of our feelings towards objects, like our bodies and sex, which we treat as at once sacred and unclean. Of miracles he holds that their possibility cannot be scientifically disproved, but at the same time he regards them as altogether "peripheral" in Christian belief, and he finds the evidence both for the Virgin Birth and for the Bodily Resurrection of Christ too uncertain to build the edifice of faith upon them.

The intellectual difficulties of the Christian faith arise no longer from any supposed conflict with natural science—evolution is accepted by "educated Christian opinion" and the Book of Genesis is mythology—but with anthropology, comparative psychology, and philosophy. At most, however, these can show only, not that the Christian hypothesis is *impossible*, but that it is *unnecessary*. Mr. Bevan's answer is that the case for Christianity rests, not on argument, but on the quality of the Christian life. "If the Church Christian wants to convince the world of the supreme value of its ideal of love, it can only do so by steadily confronting the world with the actual thing." True, but this only means that among all the millions of nominal Christians, Christianity has rarely been seriously tried. Will it ever be widely tried? That is the question.

R. F. A. H.

Hermann v. Helmholtz' Schriften zur Erkenntnistheorie. Herausgegeben und erläutert von P. Hertz und M. Schlick. Pp. x + 175. (Berlin: Julius Springer, 1921.) 90 m.

The centenary of Helmholtz's birth is the occasion of the publication of these little known writings. They are chosen for their special importance in regard to present-day problems and in particular to the recent developments of mathematical theory.

The Historical Geography of the Wealden Iron Industry. By M. C. Delany. (Historico-Geographical Monographs.) Pp. 62+3 maps. (London: Benn Brothers, Ltd., 1921.) 4s. 6d. net.

THIS is the first of a series of "historico-geographical" monographs published under the editorship of Prof. H. J. Fleure, which are to be essentially research monographs. It would greatly enhance the value of the series if in future numbers the matter were indexed or at least paragraphed with suitable headings. A single chapter of forty pages does not facilitate reference. As regards its matter, however, this short monograph is well done, although it is difficult to follow the distribution of the Wealden forest at different ages on the sketch maps provided. The author traces the iron industry in this part of England from its beginning, in Roman days or earlier, to its decline in the eighteenth century, when, as is well known, it could no longer compete with the more favourably located industry on the coal-fields. There appears to be a gap in the history of the industry for seven or eight centuries after Roman times; at any rate, the author has been unable to find evidence of its existence in that period. Some interesting details are given of the methods employed and the kind of iron work produced.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Precursors of Wireless Telegraphy.

A TRADITION is growing (cf. NATURE, March 9, p. 316), and requires scrutiny, that it was owing to discouragement by Sir George Stokes that D. E. Hughes abandoned his experiments in 1879, anticipatory of the methods and apparatus of modern wireless telegraphy. This is in contrast to all that is known of Stokes' extreme caution in advancing opinions, for which in fact he has usually been blamed, for example by Kelvin and Rayleigh in connection with spectrum analysis. From the modest letter of Hughes published in the *Electrician* in 1899, and in Fahie's "History of Wireless Telegraphy," Appendix D, which describes his very remarkable investigations, such an inference could scarcely be fairly drawn: "The experiments shown were most successful, and at first they (Spottiswoode, Huxley, and Stokes) seemed astonished at the results; but towards the close of three hours' experiments Prof. Stokes said that all the results could be explained by known electro-magnetic induction effects, and therefore he could not accept my view of actual aëreal electric waves, unknown up to that time, but thought I had quite enough original matter to form a paper on the subject to be read at the Royal Society." Hughes continues that he was so dismayed at being unable to convince them that he actually refused to write a paper on the subject until he was better prepared to demonstrate the existence of these waves, and with this end in view he continued his experiments for some years (Fahie, *loc. cit.* p. 310).

The key to the matter has, I believe, been supplied by the extracts from Hughes' original notebooks, now in the British Museum, which Mr. Campbell Swinton read at the Jubilee Meeting of the Institution of Electrical Engineers, and which he has kindly shown to me in manuscript. They show that Hughes held that in some way "the effects were due to electric conduction through the air" (NATURE, *loc. cit.* p. 316). Those who knew Stokes would expect that he would demur stoutly to such a doctrine as misleading, and would insist that "they could be explained by known electro-magnetic induction effects." For it was not unknown even before Maxwell's theory (1860–64) that the inertia of such induction could propagate waves along wires, which, if of very high frequency, would travel, as Kirchhoff showed in 1857, with the speed of light. The transcendent advance of Maxwell's definite theory, confirmed as fact by Hertz in 1886–1888, was that in favourable conditions such waves could release themselves from the matter and travel free across space; and, more fundamental still, that it is just by such free transmission that all electric and optical effects become established.

It seems clear to my mind that the affair was a misunderstanding, such as can readily be imagined, between the tenacity of the practical inventor and the insight of the theorist who was conscientiously determined not to give countenance to a misapprehension of the nature of the phenomena. But if Maxwell had been present (he had recently died), or Kelvin, who were more closely interested in the problem of the nature of the transmission of electric influence than Stokes, they would perhaps have used further efforts not to allow the subject to drop; though it would at that time have required all the resources of theory to make progress along the lines of these experiments.

The episode is so interesting from the point of view of the philosophy of history of scientific discovery, not to mention the practical application of the microphone operating by loose contacts by Hughes himself, in the manner developed much later by Branly and Lodge and Marconi, that a full statement from all aspects should be on record.

JOSEPH LARMOR.

Cambridge, March 18.

Stonehenge: Concerning the Four Stations.

JUST within the surrounding earthwork of Stonehenge there are two stones symmetrically placed with reference to each other on opposite sides of the centre. There are also two mounds in corresponding complementary (or reversed) positions. The arrangement is shown on the accompanying plan (Fig. 1), the dimensions for which have been taken from Flinders Petrie's very careful measurements as published in his work, "Stonehenge — Plans, Description and Theories" (1880).

For the purpose of this paper the arrangement is referred to as "The Four Stations." The two stones are numbered respectively (on Petrie's system) 91 and 93, and the two mounds 92 and 94.

Concerning this pair of stones and pair of mounds Colt Hoare remarks:—

> "There are two small stones within the *vallum*, and adjoining it, whose uses have never been satisfactorily defined. The one on the south-east side is near nine feet high, and has fallen from its base backwards on the *vallum*; the other, on the north-west side, is not quite four feet high; both rude and unhewn. There are also two small *tumuli* ditched round, so as to resemble excavations, adjoining the *agger*; they are very slightly elevated above the surface, and deserve particular notice, as they may give rise to some curious and not improbable conjectures" ("Ancient Wilts," i. p. 144).

Colt Hoare opened the northern mound (No. 94), and in it found "a simple interment of burned bones." He also opened the southern mound (No. 92), "but found nothing in it" ("Ancient Wilts, i. pp. 144 and 145).

From the fact that a cremated interment has been found in mound No. 94 it has been assumed that both the mounds are barrows, and that they are moreover of the same period as the Round Barrows in the neighbourhood. On this assumption it is concluded that Stonehenge was constructed during the Bronze Age period or perhaps later. The arguments for this conclusion may be briefly summarised as follows :—

(*a*) In mound No. 94 was found a cremated interment.

The two mounds are therefore barrows, and are of Bronze Age date.

(*b*) As barrows they would originally have been isolated constructions of circular bowl-shaped form. This [supposed] original form has been partly infringed upon by the bank of the main surrounding earthwork.

The circular earthwork surrounding Stonehenge is therefore of later date than the mounds, and is therefore also of later date than the neighbouring Round Barrows.

(*c*) The Stonehenge stone structure was erected after the surrounding earthwork.

Stonehenge is therefore of later date than the neighbouring Round Barrows, and was probably constructed near the end of the Bronze Age or perhaps later.

By some archæologists this argument is considered absolutely conclusive. Rice Holmes, for example, remarks :

"The stones were certainly not standing when Round Barrows were first erected on Salisbury Plain ; for one is contained within the *vallum*, which, moreover, encroaches on another" ("Ancient Britain," p. 476).

It will be observed that the whole of this argument is based on the assumption that mound No. 94 is really a Bronze Age Barrow. The mere fact that in it was found a cremated interment is, however, inconclusive, as we know that the Round Barrow people had a cuckoo-like habit of depositing a cremation in an existing hole or position originally intended for some other purpose. Col. Hawley's recent discoveries in connection with the "Aubrey Holes" furnish examples of this practice.

On Colt Hoare's plan the positions of the two stones and of the two mounds are not correctly shown, and from that plan it would not appear that they had any particular relation to each other or to the general scheme of Stonehenge.

But if the carefully made measurements by Flinders Petrie be correctly plotted to a large scale some very significant facts concerning these Four Stations at once become apparent, *e.g.* :—

(*a*) The four positions (Nos. 91, 93, 92, 94) are absolutely symmetrical in reference to each other and to the general plan of Stonehenge.

(*b*) They are all four on the same circle, *i.e.* their centres are all at the same distance from the centre of the structure.

(*c*) If a line be drawn through the centres of the two stones (91 and 93), and another line be drawn through the centres of the two mounds (92 and 94), these lines will intersect at the centre of Stonehenge.

(*d*) The two lines drawn as specified under (*c*) are at an angle of 45° (or an eighth of a circle) with

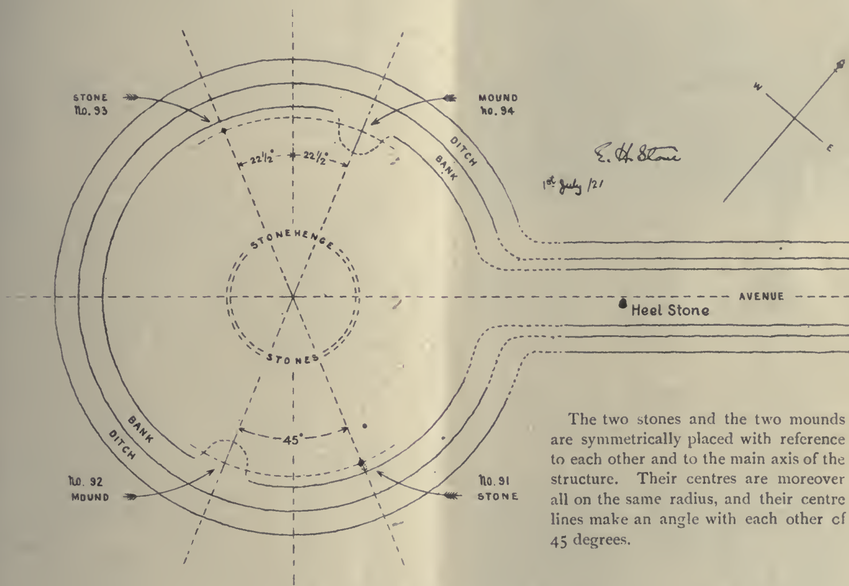

Fig. 1.—Plan of Stonehenge. Scale—120 feet to 1 inch.

each other. They moreover make equal angles of 22½° (or a sixteenth of a circle) with the cross centre line of Stonehenge.

This symmetry is very striking, and is so complete

Fig. 2.—Stone No. 91. To south-east.

that it cannot be accounted for as a mere coincidence. It obviously points to the conclusion that the Four Stations, Nos. 91 to 94, were all specially located in relation to one another as parts of one scheme to serve some definite purpose in the general design of Stonehenge.

Fig. 3.—Stone No. 93. To north-west.

On this Flinders Petrie remarks :—

"On examining the stones and mounds 91 to 94 on the earth bank it will be seen that they are exactly opposite, stone to stone, and mound to mound. This strongly shows that they are contemporaneous; as is also shown by the fact that the diameters joining their centres cross each other at . . . just half a right angle; and further the diameters are complementary to each other, being symmetrical about the axis of the structure" ("Stonehenge," p. 21).

We cannot doubt that at one time there was a stone in each of the positions now indicated by the two mounds; and that, whatever the purpose of the arrangement may have been, it had nothing to do with the neighbouring Round Barrows.

The two stones (Nos. 91 and 93), now in place, are shown in the accompanying photographs (Figs. 2 and 3). It will be observed that the ground is level around the base of each stone.

The two mounds (Nos. 92 and 94) are of very slight elevation, and are scarcely noticeable on the ground. Assuming that each of these two sites had at one time been occupied by a stone, we may suppose that the small amount of earth forming the present mound was thrown out of the excavation made when the stone was removed. When, later on, the cremated interment was buried, the incipient mound was perhaps trimmed up and added to.

It may be considered certain that the Four Stations were in no way connected with the "Aubrey Holes," and that they belong to a different period of Stonehenge history.

E. Herbert Stone.

The Retreat, Devizes.

Improvement of Visibility of Distant Objects.

In connection with the subject of some recent letters in Nature on "A Method of Improving Visibility of Distant Objects" by Prof. C. V. Raman (October 20, 1921) and by Mr. A. G. Lowndes and Sir David Wilson-Barker (November 10, 1921), it may be of interest to mention that two years ago I published a complete essay on the same question in the French Bulletin Officiel de la Direction des Recherches Scientifiques et industrielles du Ministère de l'Instruction Publique, No. 4, February, 1920, pp. 229-48, under the title "Sur l'utilité de la lumière polarisée dans les observations faites en mer ou au bord de la mer, et sur une jumelle à polariseurs."

Every advantage of polarised light mentioned by your correspondents, such as improvement of optical contrasts, visibility of colours in distant objects, etc., was considered and discussed in detail in that paper. I must mention that I took the research in hand in 1916 for military purposes, in connection with the French Ministry of Invention and Research and with the French Admiralty. The results and my former reports were communicated to the English Board of Invention and Research (1917). A little later, Prof. W. F. Durand, of Leland Stanford University, then the Scientific Attaché to the American Embassy in Paris, having been kind enough to order the translation of my reports into English, that English version was given likewise to the official agent of the British Ministry of Munitions Optical Department, Mr. F. C. Dannatt, now representative of the British Scientific Apparatus Manufacturers, Ltd., in Paris. At the end of the war the French Navy had a small number of binoculars equipped with spar polarisers of the Glazebrook-Ahrens type cemented with a special oil, as described in my paper. The constructor, M. A. Jobin, member of the French Bureau des Longitudes, supplied a few of those binoculars, at the request of the British Government, through Mr. Dannatt.

I do not wish to take up the space available in Nature with a translation of my paper, but a short summary of a few of my conclusions may be of interest.

Contrary to Mr. Lowndes's opinion, I objected very

strongly to the tourmaline plates (except for some special purposes dealing with naval artillery) on account of the high colouring they give, either green or pink, which, unfortunately, results in an inaccurate rendering of the natural tints of objects and makes ineffective one of the most striking advantages of polarised light, the wonderful and delightful disclosure of true colours in far-distant objects.

Although the choice and careful making of the Bénard-Jobin spar prisms cemented by a special poppy-oil prepared by M. Duffieux (then my assistant) to equip the Jules Huet prism-binoculars of the French Navy gave unqualified satisfaction, I must confess—and I did so in the introduction of my paper—that I feel very much inclined to consider a very thin plate of *herapathite* (sulphatoperiodide of quinine) of a few square millimetres, having its crystallographic directions quite uniform in the whole area covering the ocular-ring, as the best of all polarising equipments. I cannot say it is the most practical one, because beautiful transparent and uniform herapathite plates are not easily obtained. However, I sincerely hope that my conclusion will please W. B. Herapath's fellow-countrymen, particularly as quinine salts are more easily obtained than Iceland spar.

Nevertheless, I mentioned at the end of p. 230 of my paper the old use of tourmaline spectacles to discover the fishes in deep water, and so on. *Nihil sub sole novum.* The optical constructor to whose talents I referred in my paper, without mentioning his name, as having, when he was a young man in the 'eighties, played a hoax on his fellow-anglers along the River Marne with tourmaline spectacles forty years ago, is now living in Grenoble. His name is M. Ivan Werlein, formerly well known and appreciated for his skilfulness by French physicists and crystallographers when he was working in Paris.

HENRI BÉNARD.

University of Bordeaux, February 8.

Statistical Studies of Evolution.

SINCE Dr. Willis and Mr. Udny Yule in their reply to my letter in NATURE (March 2) have asked me to explain the case of the New Zealand flora, I feel that I should attempt to do so.

The time taken for almost all animals and probably many plants to spread to the boundaries of a continuous area of habitable environment is short compared with geological time: witness the progress of *Elodea* in this country since its introduction only some sixty years ago. Surely, therefore, the majority of species at any particular time have already reached the boundaries of that area of habitable environment to which they are isolated (*e.g.* the Marsupials of the isolated Australian region).

Now the Indo-Malayan flora of New Zealand has arrived recently, geologically speaking, and has not yet reached a state of equilibrium; it is still spreading, unlike the majority of species. As Dr. Willis and Mr. Udny Yule showed clearly in their original article, the distribution of a fauna or flora that is still spreading will conform to the "Size and Area" curve. I believe that not only a spreading fauna or flora but also one which has reached the boundaries of its habitable environment will conform to the "Size and Area" curve.

The oldest endemic families of New Zealand must have reached this state of equilibrium and, on my theory, should conform to the "Size and Area" curve. Perhaps Dr. Willis could tell me if they do so in this or in a parallel case.

C. A. F. PANTIN.

Christ's College, Cambridge, March 13.

MR. PANTIN has not replied to our query as to why neither the northern nor the southern group of plants in New Zealand shows any increase of local species when it reaches the region where the other group shows its maximum of such forms. Why is one group represented by its most widely ranging endemics at the place where the other shows chiefly its endemics of least range?

If the Indo-Malayan invasion is so young in New Zealand, why do its members, though mostly trees, show a rather greater average range than those of the herbaceous southern invasion of plants of northern-hemisphere type? Though it is a long time since Britain was cut off from the Continent, why have 227 of its 1548 species not yet reached a distribution of more than 5 vice-counties out of 112, and why have only another 229 reached one exceeding 100?

All observation goes to show that dispersal of introductions is rarely rapid, unless, as in Ceylon or New Zealand, St. Helena or North America, man has completely altered the conditions, and destroyed or interfered with the societies that already existed. A few cases like *Elodea*, chiefly water plants, are known, and it is probable that the plant entered a society that was very incomplete. No other introduction has spread rapidly in England for centuries, though when the Romans came here, and cut down the forest, thus altering the conditions, many introductions were rapidly dispersed about the country.

To suppose that species have mostly reached their possible limit of dispersal is to return to a position like that taken up by the advocates of special creation, invoking incomprehensibility. Why should *Coleus barbatus* be found through tropical Asia and Africa, including the summit of Ritigala mountain in Ceylon, while *C. elongatus*, differing only in the form of the calyx and inflorescence, and a few minor points, is confined to that summit? Why should a species of the New Zealand flora that reaches the outlying islands range much further *in New Zealand* than a species that does not? Why should one that reaches the Chathams range much further than one that reaches the Aucklands or the Kermadecs? Nothing but Age and Area can even suggest an explanation of such facts.

No theory based upon natural selection will enable one to make predictions about distribution, whereas Age and Area has already been used successfully in this way nearly a hundred times, and has increased our knowledge of the subject. If we suppose that dispersal is already completed there is little left to investigate, and to explain the distribution of species about the world (as opposed to purely local dispersal) becomes a task that has been abandoned as hopeless by leading authorities upon distribution. The fact that Age and Area can be used for successful prediction shows that it is probably correct, and it offers an explanation incomparably simpler than does the natural selection theory, and explains with ease facts utterly incomprehensible to the latter, such as that the Auckland Is. contain 45 per cent. of Monocotyledons in their flora, the Chathams 31 per cent., and the Kermadecs only 21 per cent. How can natural selection explain the remarkable maps in *Ann. Bot.* 32, 1918, pp. 343 *seq.*, and the curves on pp. 357, 360? Mr. Pantin's theory seems to us to lend itself neither to explanation nor to prediction. We feel compelled again to emphasise that his supposition as to random combinations of environmental limitations does not appear to us to bear any relation to facts. Nor, if it did accord with facts, can we agree that his conclusions would follow.

J. C. WILLIS.
G. UDNY YULE.

Radiology and Physics.[1]

By DR. G. W. C. KAYE.

THE appreciation of the physicist by the medical worker in this country is of recent growth, but radiologists, while fully alive to the enormous part that radiology will play in medicine in the future, are only awakening to the fact that, if radiology is to advance as it should, they will have to correlate it continuously with physics. They may not find such correlation very easy. Not that physicists would look askance at the idea; the difficulty is that there are so few of them who are interested. The physicist has never been taught to look upon radiology as offering a possible career. Even had he been prepared to risk it, he would not have found educational facilities to put him on his way. There are probably not half a dozen physicists employed in radiology in this country. The Germans discovered, long before the war, that the secret of progress in radiology was to bring the medical man and physicist continually together and let them work side by side. They went further and introduced them both to the manufacturer—but that is another story! Is the British radiologist in a position to submit techniques, backed up with a wealth of physical and scientific data such as the German has recently given to the world? It is to be hoped so, but the British radiologist is sadly handicapped by not being able to look to the physicist for the discharge of duties which he has neither time nor, possibly, inclination to see to himself.

Radiology needs men who have a sound knowledge of the physics of radiology and are, furthermore, well grounded in electrical engineering, especially on the high-tension side of the subject. If we could ensure a steady supply of qualified physicists and electro-technicians who knew that in their future work they need not fear that they will not enjoy, both professionally and socially, the full status of their medical colleagues, we could look forward to a desirable all-round improvement in the science and art of British radiology.

Within the last decade we have learnt that X-rays are identical with light rays in almost every particular, the main difference being that the wave-lengths of the X-rays are much shorter. Until recently, a gap of about 4 octaves existed between the shortest known ultra-violet ray and the longest X-ray, but within the last few months it has been discovered that the continuity is complete and that the X-rays follow on and, indeed, overlap the ultra-violet end of the spectrum. The study of this missing group of octaves had invited attention for some time. The grating method proved unavailing for the purpose, the wave-lengths being too small for our artificially ruled gratings and too big for crystal gratings. Further, at either end of the gap the vacuum spectrometer had proved necessary owing to the extremely absorbable nature of the rays. The problem has finally been attacked with success in this country and America by Millikan, Richardson, Hughes, and Kurth who, using indirect photoelectric methods, have traced X-ray spectrum lines of various elements right across the gap and into the already explored ultra-violet. Fig. 1 shows the positions of some of these lines.

The following are the wave-lengths in Angström units, *i.e.* 10^{-8} cm. of the regions of the spectra we have been discussing:—

Visible light	7200 to 4000
Ultra-violet light	4000 to 200
X-rays	500 to 0·06
γ-rays	1·4 to 0·01

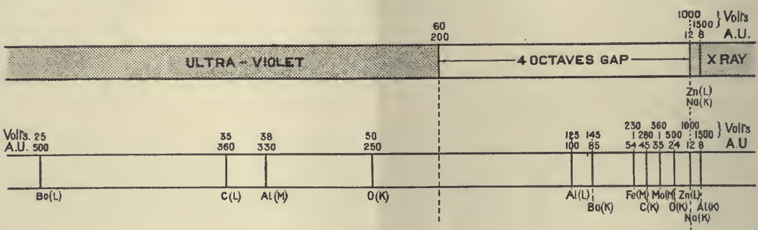

FIG. 1.

It thus appears that we can now claim a knowledge of the existence of over 13 octaves of X-rays or, including radium γ-rays, nearly 16 octaves. As yet the radiologist has only turned about 3 octaves of these to account.

As is now well known, the parallelism between light rays and X-rays is maintained by the presence of spectrum lines in the X-ray spectra. Just as the spectrum of a hot body normally consists of a continuous spectrum of white light, together with certain spectrum lines the wave-lengths of which are characteristic of the radiating material, so an element emitting X-rays not only gives out "white" radiation, but superposes its characteristic lines on the general spectrum. The characteristic X-ray spectra are found to be much less complicated than light spectra and are more readily sorted out into groups or series of associated lines. These several series, each of which includes a number of lines, are designated—J, K, L, M—and are broadly differentiated by a progressive increase in the average

[1] Abridged from the Mackenzie-Davidson Memorial Lecture delivered on February 17 at the Royal Society of Medicine.

wave-length of each group as we pass from one to another, series J having the shortest wave-length and requiring the highest voltage to excite it. It should be added that all the constituent lines of a group are excited simultaneously at a critical minimum voltage.

The work on X-ray spectra has thrown great light on the structure of the atom, and, in passing, it may be recalled that present-day theory regards all atoms, of whatever kind, as built up of two kinds of "bricks," and two only—(*a*) negatively charged electrons, and (*b*) hydrogen "nuclei," each more than 1800 times as heavy as an electron and carrying a charge equal to that on the electron, but positive in sign. Rutherford's nucleus theory of the atom, now universally accepted, regards an atom as built up of a minute positive nucleus (to which practically the whole mass of the atom is attributed) surrounded by a cluster of electrons grouped in rings. The total number of electrons in these rings is equal to the atomic number (N) of the atom in question. The nucleus of the atom is regarded as built up of hydrogen nuclei held together by electrons, the former being in excess to just such an extent that the nucleus as a whole contains N positive charges. This serves to counterbalance the N negative charges of the electron rings, the result being an electrically neutral atom. For example, platinum has an atomic number of 78. Its atomic weight determined chemically is 195. Thus, if platinum is a simple element, the platinum atom has a nucleus composed of 195 hydrogen nuclei and 117 electrons, the difference (78) serving to counterbalance the 78 electrons in the rings. The various elements differ only one from another in that they have different nuclear charges, the nucleus determining the mass and radioactive properties, while the number and grouping of the cluster of electrons in the rings control the chemical and spectroscopic properties. For example, the K radiation is supposed to arise from the displacement of an electron in the innermost ring, the L radiation from the next ring, and so on.

Within the last few years it has been established experimentally that there is a definite boundary to every spectrum of general X-rays on its short wave side. The position of this boundary (or quantum limit) is not affected by the nature of the element emitting the X-rays, but is dependent solely on the maximum voltage applied to the tube. The relationship is given by the well-known quantum equation of Planck. Substituting the accepted values of the constants, it follows that

$$\text{max. voltage} = \frac{12{,}400}{\text{shortest wave-length in A.U.}}$$

This very simple relation provides us with a scale of quality which, if not perfect, is more exact than any which the radiologist has been in the habit of using. Spectral curves of X-ray intensity are not symmetrical, the shortest waves are the dominating ones. The mean effective wave-length (or "centre of gravity") of a spectrum of rays approximates to the wave-length of the peak of the curve, *i.e.* the wave-length of maximum intensity. Now there is some evidence that this wave-length of the peak (λ_m) is proportional to the limiting or quantum wave-length (λ_o); in many cases λ_m proves to be approximately 4/3 times λ_o. But in practice it is much easier to measure λ_o than λ_m, and this fact gives an added importance to the measurement of the quantum limit and enables us to identify very fairly the quality of a mixed bundle of X-rays. No doubt something depends on the wave-form of the exciting potential, but the effect of this is probably less important as the voltage is raised. The precision of the method would be enhanced if steps were taken to standardise apparatus and technique, so that all work could be done by the use of, at most, three or four spectra the distinctive features of which, including energy distribution, could be determined and specified.

But how is the radiologist going to measure wave-lengths in his operating room? At present, the easiest plan appears to be by measuring the maximum voltage and using Planck's relation. The voltage can be obtained by use of a reliable type of electrostatic voltmeter, or, failing that, by measuring the alternative gap by means of some approved type of spark gap such as the sphere gap. Another and a better plan is to measure the quantum limit by means of a portable direct-reading spectrograph of the type designed in Germany by Seemann (Fig. 2). Incidentally, these direct-reading spectrographs act as very convenient

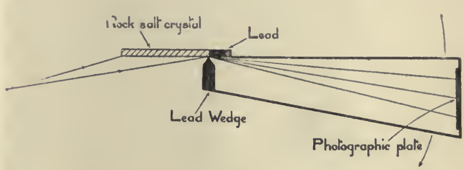

FIG. 2.

and accurate high-tension voltmeters, which afford a measure of the true maximum voltage effectively operating a tube.

There are two things that may happen to a beam of X-rays when passing through a material. Part of it may be absorbed, and is therefore wholly transformed into characteristic radiations of the material, the process always being accompanied by the liberation of electrons. The rest of the beam is scattered or dispersed which, in effect, is equivalent to stating that while the rays are unaltered in quality a considerable proportion of them have their direction altered. Scattering, which finds a close parallel in the dispersion of light by a fog, is more noticeable with light atoms than with heavy.

We explain these two effects—absorption and scattering—by supposing that absorption is caused by the flicking off by the X-ray of an electron in one of the ring systems in the atom. The outcome is the vibration of the ring systems in question with characteristic periods and the expulsion of an electron from the atom at high speed. If, on the other hand, it happens that the X-ray is incapable of definitely ejecting an encountered electron but merely jars it, so to speak, then the electron, having absorbed the energy of the X-ray, vibrates not with its own free period but with a forced period which is prescribed by the X-ray and it re-emits its new-found energy in all directions, though chiefly round and about the original direction. With a medium weight or heavy atom the proportion of scattered to absorbed radiation depends upon the wave-length and

may be small. With a light atom the amount of scattered radiation is almost always large.

The problems of scattering have come to the fore recently in radiology in connection with deep therapy. The human body is made up chiefly of carbon, hydrogen, and oxygen—all light atoms—and its ability to scatter X-rays in the adjacent air has long been familiar to radiologists, especially in screening work. But the extent of the scattering within the body itself is just as marked, and this is the case whether the rays are of medium or high penetration. It has been established by Dessauer and others, from measurements made on specified areas at various depths within the tissue, that from 60 to 80 per cent. of the effectiveness of highly penetrating rays is due to scattered rays which originally were not directed at the area in question.

The subject of protection has recently excited a great deal of attention by reason of a series of casualties to prominent radiologists. The various radiological societies and institutions in London co-operated in 1921 in the formation of a representative Committee, which was asked to go into the whole question and draw up recommendations for the guidance of all concerned. It was agreed that the question of the protection of the operator was the sole issue; the existing measures had proved to be adequate so far as the patient was concerned. The word "protection" was to be interpreted in a wide sense.

The Protection Committee was fortunate in securing Sir Humphry Rolleston as Chairman and, under his eminent leadership, has already drawn up two memoranda. They need not be referred to in detail here, but they have already been widely acted upon, and there is little doubt that presently the bogey of X-ray dangers will have been laid. In years to come this country will be entitled to congratulate itself on having given a lead to the world in this matter.

The Committee has laid down certain standards of protection against X- and γ-rays, which are expressed very simply in terms of the equivalent thickness of sheet lead. These thicknesses were based on available experimental data; for example, the X-rays from a tube excited by about 180,000 volts are cut down over 10,000 times by 3 mm. of lead, and over 1 million times by 10 mm. of lead. The choice of the actual protective material may, of course, be determined by insulating, electrostatic, or other considerations, but its thickness should be such as to provide protection equivalent to the amount of lead specified.

The Committee sought and secured the co-operation of the National Physical Laboratory, both in investigatory work and in the question of the inspection of existing X-ray departments in hospitals and other institutions. The N.P.L. has already inspected a number of X-ray departments throughout the country, and it may be said at once that, if the conditions which obtained there may be regarded as typical, the Protection Committee needs no justification in its labours. The Committee has adopted the common-sense principle that, wherever possible, the tube box or enclosure should form a complete shield in all directions, allowing only the minimum aperture for the work in hand. Few installations subscribe to this very reasonable demand. In some cases the scattered radiation in different parts of the X-ray rooms proved to be so excessive as to prohibit examination by electroscope, and observations had to be confined to noting the comparative ease with which the bones of the hand could be seen on a screen as it was carried round the room.

It is established that ventilation is of prime importance but, unfortunately, the radiological departments are generally situated in the basement. Ventilation difficulties are multiplied tenfold in consequence and, further, the rooms are largely shut off from the beneficent effects of sunshine. In the majority of cases the high-tension system consists of stretched over-head small gauge wires, connected by spring tapes, or spirally wound fine wires to the various apparatus. The resulting brush discharge produces ozone in abundance, and, as extractor fans are rarely fitted, the unfortunate operator gets the full benefit. The Protection Committee has recommended the use of smooth tubes or rods or heavily insulated wires with the object of abolishing the evils of brush discharge. It suggests the employment of commodious rooms with ample head room, especially in the case of deep therapy outfits where the exciting voltages are in the region of 200,000. Another danger is here indicated; more than one fatality has been occasioned by accidental discharge to an operator working in a small room with slack or looped high-tension wires.

Generous recognition should be paid to the X-ray manufacturers of this country for the way they are beginning to co-operate with the Committee. The British X-ray manufacturers, divided as they are, are mostly carrying on under great difficulties at the present time. Yet, despite their difficulties, almost all of them have taken steps to obtain from the National Physical Laboratory test figures for the various protective materials which they are incorporating into existing and new installations. Such measurements are rapidly and inexpensively carried out by the Laboratory, and no radiologist need deny himself the security which the N.P.L. certificate affords. The Laboratory experience amply confirms the necessity for such tests. For example, lead glass has been tested —of which only 5 mm. were required to give the protection of 1 mm. of lead. For other samples of glass as much as 10 mm. were required. The corresponding figures for lead rubber show variations between 1·7 mm. and 4 mm. as the equivalent of 1 mm. of lead. Thus, with either protective material a manufacturer can easily be 100 per cent. out in his reckoning if he employs uncertified material. He owes it to himself and his customers to take no such risks.

Two noteworthy steps, pregnant with promise for the future of radiology, were taken in the establishment of the Diploma in Radiology and the formation of the Society of Radiographers. Here again this country has taken the lead. And when some day we get an Institute of Radiology, with which Mackenzie-Davidson's name should be associated in some way, a further great step will have been taken to assist radiology in this country to take the proud position among the sciences to which its important and beneficent activities entitle it.

Forests in Relation to Stream-flow and Erosion.

One of the common marvels to the ordinary person is that so little is really known about such an everyday phenomenon as rainfall. It is a satisfaction to remember that, thanks to the British Rainfall Organization, more is known of the rainfall of Britain than of any other country, but our complacency may be a little disturbed when we reflect that for investigations as to what happens to the rain after it falls we have to turn to other lands. Water-engineers, indeed, have data from which much might be learned; but water engineers are secretive folk, and the records of investigations on the run-off of the Severn, Exe, and Medway remain the only records generally accessible. The results of these investigations, though extremely valuable, are not, however, very definite, as the areas are so large and the problems correspondingly complicated. More definite results are to be expected from the experiment being carried out by the United States Department of Agriculture in Colorado.[1] The areas dealt with are small and the problem more defined, though even in the small areas there studied conditions are by no means so simple as might be desired.

The intention of the experiment planned in 1909 was to make a complete study of the effects of forest cover on stream-flow and erosion. The main idea of the method employed is simple enough. It was, to select two small forest-covered valleys, contiguous, of the same size, similar and similarly situated, to find the rainfall and run-off from each, then cut down the forest from one of the areas and repeat observations. It appears almost a laboratory experiment. The first trouble was the trouble of the cook who desires to cook a hare, or perhaps it would be better to say, a brace of grouse, and it must be confessed at once that though two somewhat similar birds were caught they were not of the same kind, and as investigation proceeded unexpected anatomical differences presented themselves, extremely interesting in their own way, but not making for uniform cooking; it appears also that even if they had been both of a kind they were particularly difficult birds to cook. The valleys chosen lie about the 10,000 feet level in a region with precipitation about 20 inches a year, about half of which falls as snow and a goodly proportion of the rain in thunderstorms, both phenomena introducing difficulties.

The publication before us is a preliminary report giving an account of the first part of the experiment from 1911 to 1919, and discusses the data obtained while both valleys, A and B, were forest covered. Both valleys are small, B of 200 acres and A a little larger, varying in elevation from just over 9000 feet to just under 11,000 in the case of B, and somewhat over in the case of A. The geological structure is identical, namely, augite-quartz-latite, little porous to water, covered with a few feet of soil and decomposed rock, porous and sandy in texture, forming a permeable and well-drained top layer. The forest cover, conifers of various kinds, is almost identical. The valleys are not, however, of quite the same shape—A is long and narrow, B is much more like a bowl; the exposure is rather different, the centre line of A being south of east, while that of B is north of east. This is important in view of the fact that the winter snowfall runs off as it is melted by the summer sun, and indeed both the time and degree of response of the two streams to any factor influencing the *régime* are somewhat dissimilar. For example, after rainfall A rises more rapidly and reaches its maximum flow earlier than B, B may then be higher than A for a time, while at the end of the flood A may be higher than B. As a result, it has been necessary to construct tables and diagrams to show the relation of B/A for a great variety of conditions, and some 16 "rules" have been formulated for comparing the discharge of B when the discharge of A and the rainfall is known.

The readings for the run-off may probably be accepted. Very great care has been taken to construct suitable dams, gauges, and basins. The construction of the measuring apparatus is described in great detail, and the readings appear in general to have been exceedingly accurate and trustworthy. But it is a little difficult to place implicit confidence in either the precipitation statistics or the use that is made of them. Though details are, perhaps significantly, lacking, it is evident that the exposure of the gauges for rain and snow is not up to the standard required in this country, while their distribution also leaves something to be desired. Only five were set up in the two valleys; two are close together in the lower part of each basin and one at almost the highest point of A, while a sixth was just outside the lower portion of both basins.

The number would, of course, be abundant for ordinary rainfall work, but in a scientific experiment which is otherwise marked by accuracy, British experience would suggest that the number was inadequate, and we should imagine that over a vertical height of 2000 feet there would be considerable differences in rainfall, especially when a good proportion of the rain falls in thunderstorms. It is possible that conditions are different in Colorado, but we should have been more satisfied if evidence had been adduced to show that this was so. Nor is our confidence increased when we learn that in the second part of the experiment, when the forest is removed from B, only the gauges in the A valley are to be read. It is scarcely sufficient to say that "the use of the single record cannot be seriously objected to when it is considered that at the lower end of A there is the *choice of the better catch* of two gauges, and this value *is averaged* with the catch of the third gauge at the head of the valley." The italics are ours. It is only fair to say that much more care has been taken with another and equally important side of the problem, the melting of the snow. Observations of the depth of the snow at the time of thaw are taken at a considerable number of points.

It will be interesting to see in ten years' time the results of removing the forest. No doubt valuable results will be obtained which will be of use in dealing with the Forest Reservations of the Rockies, but even so, light will be thrown on only a small portion of the small problem. We shall know what is the effect of removing forest cover only under somewhat special conditions. There will be plenty room for further investigation.

[1] "Stream-flow Experiment at Wagon Wheel Gap, Colorado," Monthly Weather Bureau Supplement, No. 17. Government Printing Office, Washington, 1922.

Disintegration of Elements.

By Sir Ernest Rutherford, F.R.S.

I HAVE been asked to say a few words about a telegram in the *Times* of March 14 giving an account of a paper communicated to the American Chemical Society at Chicago by Dr. G. Wendt and Mr. C. E. Iron. It reported that, when a powerful condenser discharge at 100,000 volts was sent through a very fine tungsten wire, the filament exploded with a "deafening report," producing a flash estimated to correspond to a temperature of at least 50,000° F. The telegram states: "After the flash he (Dr. Wendt) found atoms of tungsten decomposed into simpler atoms and the result was the change of metallic tungsten into gaseous helium." The experiments were made to investigate whether any atomic disintegration can be effected by such high temperature discharges, and apparently the authors believe that they have obtained positive results.

We must await a much fuller account of the experiments before any definite judgment can be formed; but it may be of interest to direct attention to one or two general points. During the last ten years many experiments have been recorded in which small traces of helium have been liberated in vacuum tubes in intense electric discharges, and it has been generally assumed that this helium has been in some way occluded in the bombarded material. On modern views, we should anticipate that the disintegration of a heavy atom into lighter atoms, *e.g.* into atoms of helium, would be accompanied by a large evolution of energy. Indeed, it is to be anticipated that the additional heating effect due to this liberated energy would be a much more definite and more delicate test of disintegration of heavy atoms into helium than the spectroscope.

Our common experience of the large effect of temperature in ordinary chemical reactions tends to make us take a rather exaggerated view of the probable effects of high temperatures on the stability of atoms. While it seems quite probable that momentary temperatures of 50,000° F. can be obtained under suitable conditions in condenser discharges, it should be borne in mind that the average energy of the electrons in temperature equilibrium with the atoms at this temperature corresponds to a fall of potential of only 6 volts. In many physical experiments we habitually employ streams of electrons of much higher energy and yet no certain trace of disintegration has been noted. In particular, in Coolidge tubes an intense stream of electrons of energy about 100,000 volts is constantly employed to bombard a tungsten target for long intervals, but no evolution of helium has so far been observed.

Obituary.

Prof. A. D. Waller, F.R.S.

BY the death of Prof. Augustus Désiré Waller, on March 11, in his sixty-sixth year, the scientific world has lost an unique personality—a physiologist of international eminence and of exceptional calibre.

Waller studied in the Universities of Aberdeen and of Edinburgh, graduated in the former, and commenced his experimental work in Ludwig's laboratory in the year 1878. From here he proceeded to University College, London, whence he was appointed to the lectureship in physiology in the London School of Medicine for Women. He subsequently held the corresponding post in the Medical School of St. Mary's Hospital. In 1902 Waller became Director of the Physiological Laboratory of the University of London, of which, aided by the generosity of his brothers-in-law, and enabled by the wisdom and liberality of the Senate, he had been largely instrumental in securing the foundation. This post he held, amid difficulties, with conspicuous success, until his death.

Whilst at St. Mary's, Waller had felt the need of and had found the time and energy to establish and equip a library and laboratory, in his home, and it was there that most of his earlier researches were carried out. From there also he supplemented the resources of the University by the unstinted loan both of books and of valuable apparatus. He was closely associated with the Institut Marey from its inception, latterly as vice-president, and took an active part in the direction of its affairs.

Nearly 200 publications, covering a very wide field, stand to Waller's credit. Early papers on the circulatory system led to a study of the electromotive phenomena of the heart beat and to the discovery that an electrocardiogram could be recorded on the human subject. His earliest records with the capillary electrometer, though accurate, were not what he expected them to be. Influenced by this, and misled by an insensitive instrument, he subsequently published and afterwards withdrew an inaccurate picture of the electrical events in the cardiac cycle. In consequence of this mischance the credit of Waller's discovery has been wrongly attributed to others. Some years later, with the aid of a more perfect instrument—Einthoven's string galvanometer—he returned to this work, which had been meanwhile developed and extended by Prof. Einthoven in Leiden. Thanks to Waller, the string galvanometer became now, for the first time, available for clinical diagnosis in London. Its employment spread from his laboratory in all directions, notably to University College Hospital and to the National Hospital for Diseases of the Heart, in the latter of which he was appointed consulting physician.

This, though perhaps the most notable piece of Waller's electro-physiological work, was a small fraction of its total. He was the pioneer of galvanography in physiology and was the first to record, photographically, the negative variation and the electrotonic currents of nerve, both of which he studied exhaustively. Of especial interest, in this connexion, are (1) his discovery that protracted excitation of a nerve produced the same effect on subsequent negative

variations as did the administration of carbon dioxide, and (2) his inference that this similarity implied liberation of carbon dioxide by the nerve. He investigated also, in full detail, the "Nach-strom" of earlier German writers. He called this the "blaze-current," found it to be one of the earliest and last signs of life, and applied it successfully as a test of vitality in seeds.

Waller devoted much time and energy to anæsthetics, studying their effects on surviving tissues and organs as well as on the intact organism. He also devised methods for estimating the concentration of anæsthetic vapours in air and apparatus for controlling their dosage.

During the last few years Waller concerned himself chiefly with the psycho-galvanic reflex and with the physiological cost of muscular work. In the first case he elaborated and improved pre-existing technique and made valuable observations—*e.g.* on the distribution of the emotive response. The second problem he tackled with all his energy and enthusiasm. Realising the importance of testing the workman, with the least possible disturbance, in the course of his normal job, he pushed simplification of apparatus and technique to the utmost. By this he made it possible to estimate expired carbon dioxide anywhere, at short notice, and from large numbers of subjects. He did not think that his results yielded information so precise as that obtainable from more detailed analyses and more complicated and cumbrous apparatus. He urged, however, that with his simplified technique he was able to accumulate data which could not be obtained, during a normal job, by the more complicated procedures, and claimed that these data furnished a good first approximation to the physiological cost of various kinds of labour.

Lack of space prevents detailed analysis of Waller's remaining work. He made valuable contributions on the laws of excitation and of sensation, on the sense of effort, on the relation between stimulation and response, on retinal and cutaneous currents, on the kneejerk and other neuromuscular phenomena in man. He worked also with plants—on photo-electric responses, and on growth, as well as on the testing of seeds already mentioned.

In addition to his papers Waller wrote an exceptionally original "Introduction to Human Physiology." This was followed by volumes of lectures—on animal electricity—the signs of life—physiology the servant of medicine—the electrical action of the human heart, and by a very suggestive essay on the psychology of logic.

Of his public services in the foundation and direction of his laboratory it is difficult to speak too warmly. On the opening of the laboratory Waller instituted short courses of research lectures, without fee, the first of which was delivered by himself. This was followed by similar courses by physiologists from other laboratories, not merely of London but also of Oxford, Cambridge, the Colonies, Europe, and the United States. The value of such lectures proved to be so great that they were promptly adopted by most of the colleges and schools of the University, not only in physiology but also in other branches of experimental science.

Not merely problems of academic science but problems of applied physiology, in the broadest conception of the term, were undertaken by the many who utilised the laboratory for research. Some such problems have already been mentioned, and to these may be added, *e.g.*, the chemistry of metabolic processes and products; the distribution of anæsthetics in the blood; snake poison; memory, mental fatigue; surgical shock, tetanus; the testing, assaying, and standardisation of drugs; the poison gases of the war; dietetics—studied by men of such varied interests as Sir Leonard Rogers, Sir Sidney Russell Wells, Sir William Willcox, Sir Frederic Hewitt, Sir Thomas Lewis, Prof. Gamgee, Prof. Buckmaster, Prof. M. C. Potter, Prof. F. W. Hobday, Dr. F. W. Pavy, Dr. George Oliver, Dr. F. S. Locke, in addition to the laboratory staff and a whole host of younger workers. The laboratory itself and its earlier work have been dealt with more fully in a special article in NATURE of March 9, 1905, p. 441.

Waller was elected a fellow of the Royal Society in 1892. The Academies of Science of Paris and of Bologna also recognised his work, the former awarding him a Prix Montyon, the latter the Premio Aldini sul Galvanismo.

We spoke of Waller as an unique personality. He was extraordinarily energetic and able, combining boyish impetuosity and rashness with great acumen and exceptional intellectual power. He made unusually warm friends, unusually bitter enemies, and was only appreciated adequately by the greater among his scientific contemporaries and by the more intimate of his personal friends.

W. L. S.

NEWS has been received of the death, on February 3, of Professor Vladimir Ivanovitch Palladin, who for many years had been Professor of Plant Anatomy and Physiology in the University of Petrograd. Professor Palladin's contributions to botanical science consist of numerous publications, from 1886 onwards, recording his researches in vegetable physiology. These are chiefly of a biochemical nature, and many of them are concerned with the respiration of plants, some of Palladin's investigations on this subject having led him to formulate his theory regarding "respiration-pigments" and oxidases. The decomposition of proteids in plants, the formation of chlorophyll, and alcoholic fermentation are among the other subjects which he studied. An English edition of Palladin's text-book on plant physiology was published in Philadelphia in 1918, having been previously translated into both German and French.

WE see with much regret the announcement of the death on March 24, at fifty-eight years of age, of Prof. W. B. Bottomley, Professor of Botany at King's College, London, from 1893 to 1921.

WE much regret to record the death on March 21, in his eighty-second year, of Dr. J. T. Merz, author of *The History of European Thought in the Nineteenth Century*, and other notable works.

THE *Chemiker Zeitung* announces the death, at the age of 54, of Prof. Emil Heyn, director of the Kaiser Wilhelm Institut für Metallforschung, Berlin-Dahlem. Prof. Heyn was well known to metallurgists for his researches on alloys.

Current Topics and Events.

The thirteenth Kelvin Lecture of the Institution of Electrical Engineers by Sir Ernest Rutherford on "Electricity and Matter" will be delivered at 6 o'clock on May 18, and not on May 11 as previously announced.

Dr. Ernest Barker, Principal of King's College, London; Dr. A. E. Cowley, Oxford, Bodley's Librarian; and Dr. G. C. Simpson, Director of the Meteorological Office, have been elected members of the Athenæum Club under the provisions of the rule of the club which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

The library of the Rothamsted Experimental Station, Harpenden, one of the best agricultural libraries in the Empire, has recently been enriched by a rare volume (believed to be the first printed book on agriculture in France) given by Lady Ludlow, who has on several previous occasions made important gifts to this institution. The volume is entitled "Le livre des prouffitz champestres et ruraulx," and was printed by Pierre de Sainte Lucie at Lyons in 1539. It is of special interest in view of the influence exerted by the French agricultural authors of a somewhat later period on the Elizabethan agricultural writers in this country, whose influence in turn lasted almost to Victorian times.

Captain Amundsen's plans for his new Arctic Expedition for drifting across the polar basin in the *Maud* are now complete. The *Times* announces that Capt. Amundsen has left Norway to rejoin his ship at Seattle, where it has been refitted for the voyage. Sailing on June 1, Capt. Amundsen expects to enter the ice near Wrangell Island at the end of July, and hopes to reach Greenland or Spitsbergen in four or perhaps five years' time. The crew will consist of ten all told, including one Eskimo. An aeroplane for reconnaissance work is to be carried. The ship's wireless equipment has been much strengthened and now has a radius of 2000 miles. It is expected that the high-power station at Stavanger will be able to reach the *Maud* throughout its voyage. Capt. Amundsen proposes to send daily weather messages via Washington.

The summer meeting of the Institution of Electrical Engineers at the Scottish centre will be held at Glasgow on May 30-June 2 next. A paper will be read on May 31 at the University of Glasgow by Prof. Magnus Maclean on the hydro-electric resources of the Scottish Highlands, and the remainder of the meeting will be spent in visiting works and electrical installations. Arrangements have been made for tours of inspection of a number of power stations and works in the neighbourhood of Glasgow, and a two-day excursion will be made to Oban and Kinlochleven, where the British Aluminium Company's hydro-electric installation will be visited.

A summary of temperature, rainfall, and sunshine for the several districts of the United Kingdom for the winter season comprised by the 13 weeks from November 27, 1921, to February 25, 1922, was given in the *Weekly Weather Report* ending February 25. The mean temperature for the period was in excess of the average in all districts, the greatest excesses being 2°·8 F. in the north and south of Ireland, and 2°·2 F. in the English Channel district. In the south-east of England the excess was 1°·4 F. The least excess in any district was 0°·7 F. in the east of Scotland and the north-east of England. The rainfall was in excess of the average for the winter in all districts except in the south-east and south-west of England and in the English Channel. The deficiency in the south-east of England was only 0·16 in., but in the other two districts it amounted to 1·4 in. In the west of Scotland the excess was 3·70 in., the rainfall measurement being 17·98 in. The duration of bright sunshine was generally in fair agreement with the normal.

The exhibition of travel films, now being held at the Philharmonic Hall, London, under the direction of Brig.-General Sir Percy Sykes, is due to the enterprise and enthusiasm of a number of soldiers and explorers. The idea which inspired the undertaking is an excellent one and it is being admirably carried out. Each series of pictures is being produced by men who possess special qualifications for the task, and the journey is to be described either by the leader of the expedition or by a traveller well acquainted with the country. The exhibition, therefore, is of great educational value, and in many respects it differs entirely from the ordinary picture show. In the case of Burma, the pictures (by the Solar Films Co.) have been carefully selected in order to give a vivid conception of the various aspects of the people and the country. The wonderful Schwe Dagon Pagoda near Rangoon is first shown, and then scenes on the river Irrawaddy and in the hill country round Bhamo, followed by a thrilling railway journey through the tropical forest and across the Gokteik Bridge. On the way back to Rangoon the Royal Palace and shrines at Mandalay are shown. In the course of the journey the natives are seen weaving silk, climbing trees to get orchids, rowing boats with their legs instead of their arms, and directing elephants engaged in moving teak logs. The pictures, assisted by Maj.-Gen. Dunsterville's interesting explanations, leave a clear impression on the mind alike of the country, the people, and the conditions under which the Burmese live. This exhibition is to be followed by travel films of Morocco, Andalusia, Timbuctu, the Land of the Incas, and Persia.

Sir Robert Robertson gave an instructive survey of the work and scope of a scientific society in his presidential address to the West Kent Scientific Society on February 27. During the last four years forty-six papers have been read before the society, and of these nearly one-third have dealt with subjects

belonging to physics and applied physics. Next in order of numbers come zoology and chemistry—each making about one-sixth of the total—and then follow astronomy, physiology, geology, sociology, and mathematics. About 60 per cent. of the papers were by members of the society and the remainder were by visitors. In most cases the papers were descriptive accounts of results of recent work and progress in particular fields, presented so as to be intelligible to scientific workers generally rather than to specialists. The West Kent Scientific Society, like most local scientific societies, thus fulfils on a small scale, and for its own area, the functions of the British Association with which it is affiliated. Few local societies can expect to receive many communications containing new results of original investigations; first, because their proceedings, if published, are rarely easily accessible or widely distributed, and next because recognised specialist societies are usually ready to accept and publish such papers. A local scientific society ought, however, to be recognised as the natural body to be consulted upon all local matters in which scientific knowledge or guidance is required, just as the Chamber of Commerce is for commercial questions; and it is in this direction that such societies may exert most valuable social influence. Sir Robert Robertson's address ought to do something towards promoting federation and development with this end in view.

Prof. A P. Laurie's discourse delivered at the Royal Institution on February 17, on Pigments and Mediums of the Old Masters, began with the Egyptian Blue used in Egypt from the IVth Dynasty, which he had identified on the wall paintings in Crete in the Palace of Knossos. This became ultimately the blue used for wall paintings throughout the Roman Empire. Prof. Laurie has shown that it is formed within a limited range of temperature at about 850° C. when sand, copper carbonate, soda, and lime are heated together for a considerable time. The green found on Egyptian paintings is formed when the magma is raised to a higher temperature. Prof. Laurie has traced the use of this blue until about the end of the 2nd century, but it is not found on the earliest Byzantine illuminated manuscripts of the 7th century which are in the possession of the British Museum, being replaced by a badly washed ultramarine from lapis lazuli. Prof. Laurie also referred briefly to the pigments used in classical times as described by Pliny, and found by Sir Humphry Davy and other researchers on Pompeian frescoes, and traced the pigments used from 700 up to 1700 as determined, partly by literary evidence and principally by the actual examination of illuminated manuscripts, pictures, and legal rolls in the possession of the Record Office and Venetian Ducali. The history of pigments brings out interesting points, such as the close agreement between the pigments used on the Lindisfarne Gospels and Scoto-Irish manuscripts with those used in Byzantium, the gradual improvement in the preparation of ultramarine and the use of a green which was apparently verdigris dissolved in Venice turpentine. This is apparently the green found in the Van Eycks and other pictures of the 15th and early 16th centuries. Azurite was used almost universally as a blue from about 1480 to 1640, and was replaced by smalt and by an artificial copper carbonate known as blue bice. Prof. Laurie also described how tiny samples could be taken from a picture without injury, and showed the scheme of analysis for the identification of blue pigments, explaining the value of such inquiries for fixing the dates of pictures and detecting forgeries.

At the monthly meeting of the Zoological Society of London, held on March 15, the Secretary directed special attention to the acquisition by the Society of two Indian elephants presented by H.H. The Gaekwar of Baroda, a lioness, bred in India, presented by H.H. The Maharajah of Magurbhanj, and an Allamand's Grison from Pernambuco presented by Lieut.-Commander Rutherford Collins. Thirty-two new fellows were elected to the Society and thirty-five candidates proposed for fellowship. During February 126 additions to the Society's menagerie were received, 39 by presentation, 81 deposited, 5 by purchase, and one born in the gardens.

The National Union of Scientific Workers has received a number of scientific publications from the People's Commissary for Education in Russia among which are the following: "History of the World," by K. N. Malinin; "Man: his Origin, his Structure, his Future," by C. A. Chugunof; "The Foundations of Life," by P. M. Schmidt; "Life," by Sir Edward A. Sharpey Schafer, a translation of his presidential address to the British Association for the Advancement of Science delivered at the Dundee meeting in 1912; "Outline of the History of Geological Knowledge," by A. P. Pavlov; and "Spectrum Analysis and the Structure of the Atom," by D. C. Rojdestvinski. The National Union of Scientific Workers is willing to endeavour to arrange with the Russian Commissary for Education for the exchange of scientific publications between men of science in Great Britain and Russia.

In issuing their new quarto catalogue of scientific apparatus Messrs. Pye and Co. of Cambridge invite special attention to the reduced prices, which they claim are now in many cases down to pre-war level. A number of new pieces of apparatus are described, including an X-ray spectrometer, a fluxmeter, a reflecting moving coil galvanometer at 3*l.* 10*s.*, a Rayleigh stroboscope and a centrifugal force machine. A large proportion of the apparatus intended for the use of students has been designed by Dr. Searle. The catalogue consists of 150 pages, well printed and illustrated, and is bound in stiff cloth covers. The name of the firm on the front page of the cover is very readable, but there is no name on the back, and when the catalogue is placed on the shelf amongst others there is nothing except the colour of the cover to indicate whose it is. It is curious that our instrument makers should desire to render their catalogues inconspicuous in this way, but there can be no doubt about the fact, as this is the fourth case which has come to our notice in the past few months.

Our Astronomical Column.

Ratios of Planetary Distances.—Mr. F. A. Black, 57 Academy Street, Inverness, sends us a communication in which he points out a fairly close approximation which connects the ratios of the planetary distances. Using the names of the planets to denote their respective mean distances from the sun, then

$$\frac{\text{Mercury}+\text{Earth}}{\text{Venus}+\text{Mars}}=\frac{\text{Jupiter}+\text{Uranus}}{\text{Saturn}+\text{Neptune}}.$$

The logarithms of the ratios are 9·79050 and 9·78935 respectively. The approximation is sufficiently close to be interesting, though it is unlikely that it has any physical basis. It will, of course, be observed that corresponding members of the inner and outer planetary groups occupy corresponding places on the two sides of the equation.

Reid's Comet, 1922 (*a*).—Mr. H. E. Wood has computed revised elements of this comet, from Johannesburg observations on January 23 and 30, and February 5.

$$\begin{aligned} T &= 1921 \text{ October } 26{\cdot}40738 \text{ G.M.T.} \\ \left.\begin{aligned}\omega &= 183^\circ\ 31'\ \ 9{\cdot}4'' \\ \Omega &= 275^\circ\ \ 6'\ 26{\cdot}8'' \\ i &= \ 32^\circ\ 56'\ \ 6{\cdot}1''\end{aligned}\right\} &\ 1922{\cdot}0 \\ \log q &= 0{\cdot}2183570 \end{aligned}$$

The comet was photographed by Prof. Barnard on February 3, when it was of magnitude 10; it is now fading. The comet passed perihelion 86 days before discovery, and was fairly well placed for northern observers last autumn, reaching its maximum brightness (about $9\frac{1}{2}$ mag.) on December 1. The fact that it then escaped observation suggests that many comets may pass their perihelion undetected and also that possibly the search for them is not being carried on quite so assiduously as before the war. As the comet is out of reach of European observers and growing fainter, it is useless to give an ephemeris.

Wireless Time-Signals.—There are four papers on this subject in the January issue of the Mon. Not. R.A.S., from the Greenwich, Pulkovo, Uccle, and Edinburgh observatories. Prof. Sampson, in the last-named paper, brings out the facility which these signals afford for determining the errors of the individual time-determinations, for the mean of them all may be assumed to be a satisfactory datum-line. He gives curves of the errors, which demonstrate the curious fact that each observatory is liable to be in error by as much as 0·2 sec., and that the error frequently persists for some weeks in the same direction. The cause is obscure; lateral refraction, due to dissymmetry in the distribution of atmospheric pressure is examined but is insufficient to explain the whole anomaly. Prof. Sampson infers that the observations throw grave doubts on the exactitude of accepted longitude results, which generally rest on special observations made during limited periods. It seems likely that better results may be obtained by using the whole of the clock comparisons made by wireless over periods of several years. Under the old method of observing, personal equation necessitated interchange of observers, but with the travelling-wire method the difference of observers is reduced to vanishing point. There are two precautions to be observed: first, the time-signals, which are necessarily made with a predicted value of clock-rate, must be corrected by later observations at the sending observatory; secondly, the same system of R.A. of clock stars and mean sun must be employed at both stations; it may be pointed out that the *Connaissance des temps* value of the R.A. of mean sun (used at Paris) differs by 0·06 sec. from the value in the Nautical Almanac; the former uses Le Verrier's solar tables, the latter Newcomb's.

Stars of the β Canis Majoris Type.—The Journal of Royal Astronomical Society of Canada for February contains a study of these stars by F. Henroteau. They were at first supposed to be simply spectroscopic binaries, with periods of 3 to 6 hours; but the author expresses doubt as to whether this is the true explanation of the changes of wavelength, as the amplitudes, shape, and periods of the velocity curves all show variations, as do also the widths and intensities of the spectral lines. A list is given of 24 stars suspected to be of this type: one of them is 12 Lacertæ, which Prof. Guthnick has investigated with the photo-electric photometer at Babelsberg, finding a small light-variation in the same period as the change of radial velocity. The suggestion is made that they may be binaries in course of formation, rotating Jacobian ellipsoids, or binaries disturbed by a third companion. The stars are nearly all of type B, which is the type where Dr. Jeans found that fission is most likely to take place.

Spectroscopic Parallaxes with Objective Prism Spectrograms.—It has been thought that slit spectrograms on a large scale were necessary for the determination of spectroscopic parallaxes, but Dr. Harlow Shapley and Mr. Bertil Lindblad show in Harvard College Observ. Circ. No. 228 that good results can be obtained using the large stock of objective prism spectrograms available at Harvard. The pair of lines most used are 4215 (ionised strontium) and 4326 (iron); use was also made of the cyanogen bands and the lines of hydrogen, calcium, and manganese. The research is at present limited to naked-eye stars of types Ko to K2. A list of fifty parallaxes is given; the largest being λ Sagittarii 0·113″, and δ Leporis 0·091″ (this large value accords with its proper motion of 0·696″). The probable error of a deduced absolute magnitude is of the order of 0·3 mag., which is satisfactorily small.

The Sun's Rotation from Spectroheliograms. The spectroheliograms used in this investigation[1] were taken at the Yerkes Observatory between 1903 and 1909 by Prof. Philip Fox, Director of the Dearborn Observatory. The conversion into heliographic longitude and latitude was effected graphically, the image being projected by a lantern on to a globe marked with circles and tilted into the requisite position. The following formulæ were deduced for ξ, the mean daily motion:—

Northern hemisphere . $\xi = 11^\circ{\cdot}107 + 3^\circ{\cdot}449 \cos^2\phi$.
Southern " . $\xi = 12^\circ{\cdot}143 + 2^\circ{\cdot}408 \cos^2\phi$.

The differential motion of flocculi round spots is investigated, and is found to indicate an *anticyclonic* whirl, *i.e.* opposite to the rotation of the sun on its axis, in the case of single spots, while it is *cyclonic* round the leading spots of bipolar groups.

A diagram is given comparing Fox's results with those of other observers. It shows that the angular speeds of the following classes of objects form an ascending series, the increase from first to last being about 1° per day: Reversing layer, Sun-spots, Faculæ, and Flocculi (present work), λ4227 (Adams), Hα (Adams).

[1] Publications of Yerkes Observatory, vol. iii. part 3.

Research Items.

AN AMERICAN PITT-RIVERS MUSEUM.—The famous ethnological collection made by General Pitt-Rivers first became known to students when it was exhibited at the Bethnal Green Museum in 1874–75. In 1883 it was presented to the University of Oxford, and since then, under the direction of Mr. Henry Balfour, its value has greatly increased. The distinguishing feature of this museum is that the exhibits are arranged, not in geographical or racial order, but in series illustrating the evolution of the chief human inventions. A collection of the same kind was made by the authorities of the United States National Museum for the Trans-Mississippi Exhibition held at Omaha in 1898, and since then it has been developed by distinguished anthropologists like Mason, Holmes, and Walter Hough, the author of an interesting pamphlet discussing it, entitled "Synoptic Series of Objects in the United States National Museum illustrating the History of Inventions." This pamphlet describes, with a good series of illustrations, the chief inventions in the order of their development—fire-making, torches and candles, lamps, cooking utensils, knives and forks, and so on. The vast resources of the American collections have produced a fine series of examples. The present pamphlet, adapted to our collections, might well serve as the basis for a popular manual of ethnology.

STONE IMPLEMENTS IN THE PERTH MUSEUM.—It is a matter of great importance that the collections in our provincial museums should be made more readily accessible to students. They often contain exhibits of considerable value, either the result of excavations in some local area with its store of antiquities, or of the benefactions of local collectors or of travellers who have brought material from abroad and are proud to share it with their neighbours. The student, if catalogues are available, will often find stored away in some local collection just the link which he needs in some line of research. Perth in its museum happily possesses exhibits of both these types—some implements locally discovered, and those brought from foreign countries. In the Transactions of the Perthshire Society of Natural Science (vol. vii, part 3) Mr. J. Asher publishes an excellent catalogue of the collection, with full descriptive notes and photographs of the more interesting specimens. He has also given references to works of authority, Proceedings of learned societies, and the like, in which objects of a similar type are described or discussed, and it is satisfactory to learn that copies of all the publications to which reference is made are to be found in the Society's library. The Society has set a good example, which should be followed in the case of all provincial museums.

INDIAN FISHING TRIBES IN VANCOUVER'S ISLAND.—The thirty-fifth annual report of the Bureau of American Ethnology for the year 1913–14 is somewhat belated owing to the war, but it contains matter of much importance. It is devoted to a monograph by Dr. Franz Boas on the Kwakiutl, a name applied to a group of Indians on the Pacific coast in the vicinity of Fort Rupert, Vancouver's Island. Dr. Boas has edited the material collected by Mr. G. Hunt, a mixed-blood Kwakiutl. This group of Indians now numbers about 2000 souls, but it is gradually decreasing. They speak languages of the Wakashan linguistic stock, closely allied to the Nootka. Many tribes on this part of the coast, gaining their livelihood by fishing, are distinct both in physical characteristics and language, but their culture is of an uniform type, and their industries, arts, beliefs, and customs are markedly different from those of all other Indian peoples. Closer study, however, discloses many elements peculiar to single tribes, which show that this culture is the natural result of a gradual and convergent development from several distinct sources or centres, every one of these tribes having added something peculiar to itself to the sum of this development. This monograph will hold a high place among the publications of the Bureau, and it is full of interest to the anthropologist, sociologist, and student of folk-lore. In particular, the account of food and cooking, due to Mrs. Hunt, an accomplished housewife, is admirable. The detail of fishing customs is more elaborate, and there are important sections on birth, in particular on the subject of twins, and the customs of distributing the trophies of the chase. For the philologist the text is supplied both in English and in the local dialect.

NEW SURVEYS ON THE ARCTIC COAST OF ASIA.—While exploring the North-east Passage in 1918–19, Capt. R. Amundsen wintered his vessel, the *Maud*, in lat. 77° 32′ 36″ N., long. 105° 40′ E., in the vicinity of Cape Chelyuskin, the most northerly point of the mainland of Asia. During the five months spent at Maud Haven a considerable amount of useful survey work was carried out in Taimir peninsula. Mr. H. U. Sverdrup, a member of the expedition, gives an account of this work, accompanied by a chart in *Naturen* (January-February 1922), the publication of the Bergen Museum. The previous map of Taimir Land was very incomplete, although considerable detail on the coast line was added by Vilkitski in 1913. The map now shows a long fjord on the east, where only a bay had been previously known. Toll Bay, on the south-west, also ends in two long narrow fjords. Exploration of the interior reveals a plateau-like structure where the range of the Birranga Mountains were formerly placed. Around the plateau lies a raised beach some five to twenty miles in width. Observations place Cape Chelyuskin in lat. 77° 43′ 26″ N., long. 104° 17′ E. No new surveys appear to have been made in Nikolas Land and Alexis Island, although the Norwegians visited the latter. The paper also contains a summary of the meteorological observations taken at Maud Haven.

RAINS OF FISHES.—For just on four hundred years circumstantial stories of fish falling with rain have appeared in various parts of the world. Naturally, such strange occurrences have given rise to much speculation and many even stranger theories by way of explanation. The whole subject is admirably reviewed by Dr. E. W. Gudger in the November-December issue of *Natural History*—the Official Organ of the American Museum of Natural History, which has just reached us. Dr. Gudger accepts such occurrences, and rightly, as well authenticated; he accounts for them as due to the agency of high winds, whirlwinds, and water-spouts, which could easily draw up either from the sea or rivers, shoals of small fishes swimming at the surface in the track of these uplifting agencies. As their force is spent they distribute their victims along their path.

BREEDING HABITS OF THE MERLIN.—A series of very valuable and interesting notes on the breeding habits of the merlin was commenced some time ago in *British Birds*. In the March issue, Mr. W. Rowan, the author, describes the rearing of the young.

The task of feeding them falls entirely upon the female, though the food is always brought to her by the male, who also feeds his mate. He brings her but two meals daily, one just after sunrise, the other just before sunset. But these are supplemented by small portions taken from the supply brought for the young. Titlarks formed 90 per cent. of the prey, which included also skylarks, thrushes, ring-ousel, and snipe. Invariably the victims were beheaded and deplumed at a distance from the nest. At times, however, some were brought partially plucked, when the female would give each youngster in turn a mouthful of feathers only, the mother herself partaking, apparently for digestive purposes. Mr. Rowan was never able to satisfy himself as to the means by which the transference of the prey from the male to his mate was effected. As he hove in sight she would fly out to meet him, then at incredible speed pass beneath him and seize the prey. But whether it was dropped, or snatched from his talons, he could never discover.

SHELL-STRUCTURE IN FORAMINIFERA.—Prof. W. J. Sollas, from an examination of the widely known Carboniferous foraminifer, *Saccammina Carteri*, has been led to make a detailed study of the shells of calcareous foraminifera in general (*Quart. Journ. Geol. Soc., London*, vol. lxxvii. p. 193, 1921). He shows that the mineral in both perforate and imperforate types is calcite, and that some imperforate species have a vitreous appearance. In the ordinary vitreous foraminifera the shell is composed of minute prisms of calcite set with their longer axes perpendicular to the wall; in porcellanous types, no such regularity is shown by the calcite "fibrils" that are present, and these sometimes pass into a granular structure. Blind canals, but not perforations, occur in the walls of Peneroplis, and it is suggested, from observations by Douvillé, that the alleged perforations of the characteristic Upper Palæozoic genus Fusulina may be of the same nature. The author removes "*Saccammina*" *Carteri* from the arenaceous to the calcareous imperforata, and points out that the mosaic structure of its shell finds a counterpart in Spirillina. He proposes that the genus should now be called *Saccamminopsis*.

CLIMATES OF THE PAST.—In a brief but illuminating review of the climates of past geological periods, Dr. Charles Schuchert (*Amer. Journ. Sci.*, vol. cci., p. 320, 1921) concludes that climatic changes were "very slight during the middle parts of the geologic periods [as defined by faunistic changes], when the world has almost no temperature belts; and variably greatest during the earliest and latest parts. . . . To-day the variation on land between the tropics and the poles is roughly between 110° and −60° F., in the oceans between 85° and 31° F. In the geologic past the temperatures for the greater parts of the periods of the oceans was most often between 85° and 55° F., while on land it may have varied between 90° and 0° F. At rare intervals the extremes were undoubtedly as great as they are to-day." The author believes that for long epochs the greater part of the earth has had an almost uniformly mild climate, with no winters; but he opposes F. H. Knowlton's view that there was a continuous nonzonal arrangement of climate prior to the Pleistocene period. It will be remembered that Dr. Schuchert (see NATURE, vol. cvii. p. 501) connects the limits between geological periods with diastrophic events, and the influence of these, when they are of worldwide importance, is probably effective in breaking up the conditions that tend to equality of climate. In the same journal (vol. ccii. p. 187) Mr. Knowlton replies to Dr. Schuchert, and also to a criticism by Prof. Coleman. He relies on a dual control of temperature in geological times by the internal heat and also by the sun, and believes that the earth was until recently surrounded by a cloud-envelope, maintained by the internal heat, but diminishing from time to time when this heat declined. Few geologists will agree with him in minimising the evidence for the occurrence of occasional epochs of clear air and unchecked sunlight. Surely, moreover, deposits of gypsum are not usually regarded as products of marine lagoons, and the difficulties raised on this matter by Mr. Knowlton seem mostly of his own making. If his cloud-envelope could be regarded as a reality, a good deal of biological as well as physical evidence would have to be reconsidered.

RAINFALL IN LATIN AMERICA.—The United States *Monthly Weather Review* for October 1921 contains articles by Mr. E. Van Cleef and Mr. B. O. Weitz on "Rainfall Maps of Latin America," "Some Illustrative Types of Latin-American Rainfall," respectively. The first article, when dealing with the plotting of the data, mentions that the observations are not always for corresponding periods, and as no correction has been made for this the results are not always comparable, although in drawing the isohyets considerable judgment has been used. The author makes no pretence that the maps give a final statement of the distribution of rainfall, and he states that it may require another 75 years or longer before there is sufficient accumulated data to produce an accurate map. Average maps are given for the year and for the summer and winter. In addition to these there are short accounts explanatory of the rainfall over certain areas, viz. in Mexico, Central America and Panama, and South America. The problem of the *llanos* of Columbia and Venezuela is dealt with, and it concludes with the statement that the cause of the apparent dryness of *llanos* and the absence of trees in interstream areas must remain in the hypothetical stage. The second article is illustrated by graphs showing the annual and monthly averages of rainfall at 25 representative stations in Latin America. The article concludes by stating that the discussion has not covered the complexity of all rainfall types but only those which are most essential. A praiseworthy attempt has been made to associate the climatic controls with various rainfall types.

THE CLAUDE AMMONIA PROCESS.—In the Claude process, in which ammonia is synthesised from nitrogen and hydrogen under a working pressure of 1000 atmospheres, the heat produced in the reaction was at first removed by circulating molten lead round the reaction tubes. This was found, however, to lead to undue strain in the tubes leading to fractures (see NATURE, February 16, p. 219), and a new method has been adopted, an account of which is given by M. Georges Claude in the *Comptes rendus* of the Paris Academy of Sciences for March 6. Uniformity in temperature of the reaction tubes is secured by jacketing them with asbestos or kieselguhr. The heat of combination of the two gases is utilised to heat the entering gas to about 500° C. No preliminary heating is now required, and the tubes are so proportioned that the gases are heated in the catalytic tube gradually as required by the reaction. Among other advantages, the head of the tube carrying the connecting screws is almost at room temperature and the external tube supporting the high pressure is only heated to a high temperature at one end, which can be appropriately strengthened. The method works excellently in practice and has been in use for over twelve months.

University Education in the United States of America.

THE advance sheets of the biennial survey of education in the United States for 1916–18, which constitute Bulletin, 1920, No. 34,[1] contain, in addition to the statistics for the period, an illuminative comparison with figures taken from the reports of earlier surveys which leaves no doubt as to the growth in popularity of higher and university education in America. Exhaustive information is given in the numerous tables, and a number of charts have also been constructed which naturally make a stronger appeal to the eye and emphasise the striking results disclosed by the statistics.

For the year ending June 1918, the Bureau of Education received reports from 672 universities, colleges, and professional schools, the latter term comprising schools of theology, law, medicine, veterinary medicine, dentistry, and pharmacy. Of this total, more than half did not enrol more than 300 students, while of the bigger institutions, only 37 enrolled more than 2000. Thirteen of the latter had from 2001 to 3000 students; nine, from 3001 to 4000; seven, from 4001 to 5000, and eight had more than 5000. Obviously there are many very small colleges and universities and few large institutions. In fact, 10 per cent. of the colleges enrolled 50 per cent. of the students in America and a half of the total number of schools took 87 per cent. of the student populace.

That the tendencies indicated by these figures are not transitory is borne out by Bulletin, 1921, No. 21, on higher education in 1918–20.[2] There it is stated that of 250 institutions supplying returns for the periods 1916–17 and 1919–20, the smallest institutions are showing the biggest percentage increases in enrolment; those enrolling less than 250 in 1910 increased 38 per cent., those with an enrolment of 250-499, 20·2 per cent., those with 500 to 999, 14·5 per cent., those with 1000 to 1999, 22·5 per cent., and those with 2000 and over, 29·4 per cent.

The teaching staff employed in 1917–18 consisted of 29,509 men and 7013 women; *i.e.* an aggregate of 36,522, of which nearly 81 per cent. are men. These figures, when compared with those for the public high schools, in which men constitute 35 per cent. of the teachers, and for the elementary schools, where they form 13·4 per cent. of the staff, show clearly that the tendency is for women to monopolise the elementary and secondary school work while men control the higher institutions. The argument is strengthened by the facts given in Bulletin, 1920, No. 48,[3] on the statistics of State universities and colleges for the year 1919–20, from which it appears that of a total of 13,951 professors and lecturers, 11,659 or 83·6 per cent. are men.

The salaries received by professors and others during the period 1918–20 is discussed in Bulletin, 1921, No. 21, where it is stated that, in privately supported institutions, professors received on an average about 460*l.* per annum and lecturers 240-360*l.*, while in State colleges the salaries averaged 625*l.* and 280-420*l.* respectively. Caustic comment is made on the fact that structural-iron workers and railway employees were receiving more than many assistant professors in private institutions and almost as much as those in State colleges.

The numbers attending universities and colleges have grown from 156,449 in 1890 to 375,359 in 1918, an increase of more than 139 per cent. Enrolment has outstript the growth of population, which has increased from nearly 63 to more than 105 millions, or 68 per cent. increase, but high-school enrolment has increased at an even greater rate. Colleges and universities have not succeeded in attracting, in recent years, so high a percentage of high-school students as formerly. It is thought that the vocational courses now offered by many of the larger high-schools may account for the decrease in the proportion of high-school students who enter the universities. According to Bulletin, 1921, No. 21, an attempt is to be made by the American Council of Education, and a council for education in management composed of representatives of industry, to develop a form of vocational education in the higher institutions which will familiarise men with the technical side of industrial work and also prepare them for managerial positions in industry.

The position of higher education, however, is indicated more clearly by an examination of the enrolment figures in comparison with the proportion of the population which was of college age. From this it appears that in 1898, 3·3 per cent. of the population of age 19-23 years attended college, while for 1916, 4·8 per cent. is recorded. Thereafter is a drop in the percentage, due to the war, but the curve illustrating the figures for the various two-year periods from 1890 onwards shows an unmistakable upward trend. The curve showing the proportion of the population of 23 years of age on which baccalaureate or first degrees were conferred shows a similar steady rise. In 1890, less than 1·3 per cent. graduated; in 1916, almost 2·2 per cent. of this group of the population received first degrees; in twenty-six years, therefore, the proportion of graduates was almost doubled. Moreover, the proportion of the total number of students in the universities and colleges that were graduates increased from 1·5 per cent. in 1890 to 4·3 per cent. in 1916, showing that an increasing amount of time was being spent on what may be termed post-graduate work.

The personnel of the student body has also changed considerably during the past thirty years. In collegiate and graduate departments, the number of men increased from 44,926 in 1890 to 164,075 in 1916, an increase of 265 per cent., and the number of women from 20,874 to 95,436, an increase of 357 per cent. If all the students in all departments are included, these increases are reduced to 143 per cent. and 156 per cent. respectively; in any case, however, it is noteworthy that the number of women students has increased more rapidly than the number of men.

A striking increase has also occurred in the number of first degrees conferred yearly during the twenty-six years ending 1916. For non-professional departments alone, the figures are 7319 for 1890 and 31,826 for 1916, an increase of 335 per cent., while the total population of the United States was increasing by 63 per cent. A graph constructed to compare the rates of increase in the total population and in the number of students receiving baccalaureate degrees from 1870 onwards makes this point very clear. If the number of students receiving first degrees is taken as a criterion of national education, the United States as a nation is undoubtedly becoming better educated year by year. In 1918, there were 28,052 baccalaureate, 3480 graduate, and 736 honorary degrees conferred, while 499 men and 63 women

[1] Bulletin, 1920, No. 34. Statistics of Universities, Colleges, and Professional Schools, 1917–18. Prepared by the Statistical Division of the Bureau of Education under the supervision of H. R. Bonner. Government Printing Office, Washington, D.C. 1921. 20 cents.

[2] Bulletin, 1921, No. 21. Higher Education, 1918–20. By G. F. Zook. (Advance sheets from the Biennial Survey of Education in the United States, 1918–20.) 1921. 5 cents.

[3] Bulletin, 1920, No. 48. Statistics of State Universities and State Colleges for the year ended June 30, 1920. 5 cents.

received the degree of doctor of philosophy by examination from 46 institutions.

An attempt has also been made to calculate the proportion of the population which American graduates form. The number of first degrees awarded in 1870–1918 is estimated as 1,058,527, and it is calculated that 908,469 of these graduates were alive in 1918. The total population in 1918 is estimated at 105,253,300, so there was one college graduate to every 116 persons in the country. Taking adults of 23 years and over, the figures become 1 in 61.

The extent of the work undertaken in the colleges and universities is indicated to some extent by the size of their libraries. In 1890, the average number of volumes in a college library was less than 7000. In 1918, this figure had grown to 42,000, while two universities had libraries of more than a million volumes each. The total number of volumes in all the libraries in 1918 was considerably more than twenty-three millions.

The financial position of institutions for higher education in the United States is of interest if only for the sake of comparison with the funds at the disposition of similar institutions in Great Britain. Some of the more outstanding figures have been converted into sterling at the rate of five dollars to the pound, and the results are given in round numbers. Endowments in 1890 amounted to some fifteen million pounds; in 1918, the total was more than ninety-six millions, a similar increase to that shown by the growth in the libraries. During this period, however, the number of students had increased and a better measure of the increase of productive funds is given by comparing the value of such per student enrolled. In 1890, the value was 98*l.* per head and in 1918 it was just over 256*l.*, an increase of 162 per cent. Thus it is doubtful if the increase per head in endowment has really kept pace with the increasing cost of higher education. This statement is borne out by the fact that the percentage of total income coming from endowment funds has steadily decreased during the past 28 years.

The gifts and benefactions reported for the year 1917–18 amounted to just over 5,500,000*l.*; of this amount about 1,100,000*l.* was for increasing plant, 1,000,000*l.* for current expenses, and 3,400,000*l.* for endowments. Thirty-six institutions received gifts of more than 20,000*l.*, and seven of these had benefactions exceeding 200,000*l.* Among these latter were Yale University and the University of Chicago, which received sums amounting to about 570,000*l.* and 420,000*l.* respectively. According to reports for the years 1918–20 received from 317 higher institutions, 27,600,000*l.* was received in benefactions, of which 8,900,000*l.* was for current expenses, 4,800,000*l.* for increase of equipment and plant, and 13,900,000*l.* for endowments. During this period, Harvard University received more than 2,000,000*l.*, Massachusetts Institute of Technology 1,200,000*l.*, and the University of Chicago nearly 1,000,000*l.*, to quote a few of the more noteworthy increases in endowment. These figures, of course, are exclusive of any grants received from Federal, State, or municipal resources.

The value of the property owned by colleges and universities during the period 1890–1918 was ascertained and figures are given for the average value per student. In 1890, this was 108*l.*, while in 1918 it had increased to 279*l.* The property value per student in 1918 was therefore more than two and a half times what it was in 1890, though the fact that the war had reduced the number of students slightly makes the figure for 1918 somewhat high.

The total receipts in 1918 of the universities, colleges, and professional schools in the United States were nearly 30,700,000*l.*, and of this sum about 27,400,000*l.* was reckoned as working income. The corresponding figures for 1892 were about 5,600,000*l.*, and 4,200,000*l.* The average working income per student, however, increased from 14*l.* in 1892 to 73*l.* in 1918; in other words, in 1918 it cost more than five times as much per year to provide education for a student as it did in 1892. Although slightly accentuated by the war, the cost of higher education has been increasing at a steady rate during the whole of this period of 26 years.

The percentages of the total income obtained from the various sources, Federal, State, municipal, students' fees, endowments, and benefactions, also changed considerably between 1892 and 1918. Students' fees have contributed a fairly steady 25 per cent.; the proportion from endowments has decreased steadily from 18·5 per cent. in 1892 to 14·6 per cent. in 1918, while benefactions have, on the whole, also provided a decreasing percentage. Grants from Federal funds increased in general, but the percentage of the total income derived from this source decreased steadily. The State and local authorities have provided a very variable proportion of the income; in 1896, it was only 10·6 per cent., but by 1918 it had risen to 27·2 per cent. Supplementary data for the year 1919–20 are given in Bulletin, 1920, No. 48, which, of course, refers solely to State institutions. The total working income of the 92 universities and colleges which furnished returns for that year was 18,200,000*l.*, of which some 1,800,000 was derived from students' fees, and 1,900,000 from private benefactions. Expressed as percentages, the varying proportions of the total income were contributed as follows: students' fees 9·6 per cent., private benefactions 10·3 per cent., Federal grants 9·0 per cent., State grants 60·6 per cent., and 10·5 per cent. was from miscellaneous sources. The proportion provided by the State is naturally large in State institutions, but the general trend of the figures supports the conclusion reached in Bulletin, 1920, No. 34, that higher education in the United States is coming to depend more and more upon the State or municipality and less on the income derived from productive funds, private benefactions, and Federal grants.

Marine Borers in San Francisco Bay.[1]

AN interesting progress report on the San Francisco Bay marine piling survey has recently been issued by a committee which affords an excellent example of co-operation between science and industry. The Committee was composed of representatives of the American Wood-preservers' Association, the Forest Service, and the Department of Zoology of the University of California, and the necessary funds were contributed by interested parties in the district.

Early in 1914 the activity of marine borers was noticed in the dykes of the Mare Island Navy Yard in San Pablo Bay—the northern arm of San Francisco Bay. The shores of San Pablo Bay have attracted

[1] Report on the San Francisco Bay Marine Piling Survey, prepared under the supervision of the San Francisco Bay Marine Piling Committee of the American Wood-preservers' Association. 1921. Pp. 104+36 plates.

many large industries, the water-front structures of which had been built on untreated piles because it was believed that the discharge into the bay of fresh water by the rivers would prevent invasion by salt water and therefore the advent of marine borers. The attack of 1914 appeared to be sporadic, like earlier ones which had been reported as far back as 1870, but in 1917, at Mare Island, attacks by the same "ship-worm" (Teredo) again occurred, and during the following years spread rapidly and increased in severity. By the latter part of 1919 the attacks had progressed to such an extent that parts of water-front structures, and, in some cases, whole docks, began to fail, and the report of the committee appointed to investigate the problem is now before us.

The marine borers at work in the area comprise the most widely known and most destructive representatives of the groups to which they belong, in addition to one other species which seems to be, as yet, purely Californian. Of the boring molluscs, the first considered is *Xylotrya setacea*, which, when full grown, reaches a length of two feet or more. Details are given of its external features and internal structure. Reference is made to the capacious pouch opening out of the stomach, which serves as a receptacle for the particles of wood rasped off the burrow by the shell. The mechanism of burrowing has been carefully studied, and it is shown that the contraction of the stout, reddish posterior adductor spreads the shell-valves apart and causes their edges to rasp away the wood; the return of the shell-valves to the initial position, ready for the next thrust, is accomplished by the small, weaker, anterior adductor muscle. The shell-valves are not attached to each other by a continuous dorsal hinge (as in the fresh-water mussel), but are widely separated except at two knob-shaped projections which meet in the middle line and serve as fulcra for the rocking movements of the two valves. The cutting action is due to the contact of the anterior face of the shell with the wood and the scraping of this finely ridged edge over the wood by the outward thrust of the shell as the powerful posterior adductor muscle contracts. The shell is held in contact with the bottom of the burrow by the sucker action of the foot. The chips cut away are not more than 0·01 mm. wide, and are several times as long as wide. Prof. Kofoid states that when the borers are active it is possible to hear the rasping of their tools on the wood by placing the ear against the top of the pile.

A short account is given of the life-history of Xylotrya. The eggs are expelled, and fertilisation takes place in the water; the larva forms a velum, develops a pair of shell-valves and a tongue-like protrusible foot. After swimming for about a month the larva, now about 0·75 mm. long, settles down, preferably on wood, and usually near the mud-line. It fastens itself to the wood by a sticky byssus thread, secreted by a gland in the base of the foot, the velum is absorbed, and the foot is transformed into a sucker; the adult type of shell is produced, the elongate siphons are formed, and the animal begins its boring operations. Thirty days after attachment it is about 63 mm. long, and begins breeding, and by the following summer it attains the length of two feet. The largest burrows of this species met with were ⅞ in. in diameter in their lower portions, and more than 30 in. long.

A short notice is given of *Teredo diegensis*, the smallest of the molluscan borers in this area, which was distinguished from other species in 1916. It is only known from the Californian coast, and is of least importance from the economic standpoint.

The well-known "ship-worm," *Teredo navalis*, is considered more fully, as befits its greater importance. This species seems to reach sexual maturity in the first year of its growth. Prof. Kofoid records a heavy death-rate in the autumn, associated with falling salinity of the water, and there is also a heavy death-rate in the crowded territory near the mud-line. The eggs are reported to be retained in the female until they develop into larvæ, which, on liberation, become at once free-swimming. The larva may be carried by tidal currents for long distances, but Prof. Kofoid remarks that, so far as records are available, no evidence exists to show that *T. navalis* has heretofore been found on the Pacific coast; it is, however, only a question of time before this pest will appear in other ports on the Pacific coast. The number of larvæ which may settle on a given pile seems to be limited only by the surface; 437 were counted on a square inch.

Of the three well-known crustacean borers—Limnoria, Sphaeroma, and Chelura—which attack marine structures, only the first two have been found in San Francisco Bay. Limnoria (the gribble) produces few young, but these are not free-swimming, and are ready at once to dig in for themselves. The colony of Limnoria in timber extends peripherally and the burrows constantly deepen. A square inch of Douglas fir heavily attacked by Limnoria was found to contain 79 females, 82 males, and 221 young. Limnoria works at all levels in harbour waters, from near the mud-line to the uppermost tidal level, but is most active between tide-marks, often whittling away the piles to an hour-glass shape. It may be found at work even in the creosoted zone of a pile. Whether it has become slowly acclimatised to the repellent substance or whether creosoting was defective is not known, but Prof. Kofoid states that it is possible, by gradually increasing the strength of the solution, to acclimatise Limnoria experimentally to live and thrive in solutions which originally would have been deadly. *Sphaeroma pentodon* is of small economic importance.

In a general account of the biological indicators of Teredo, Prof. Kofoid points out that, as this mollusc enters the wood as a minute larva and there is only a pin-hole to mark its entry, a close inspection with a lens is necessary to reveal these small openings. But there are other marine animals easily identified and quickly recognised, which may be taken as indicators of conditions suitable for the occurrence of Teredo, and among these he names the barnacle and hydroids, which, from the results of the Californian survey, precede Teredo as part of an invading marine fauna. Their presence, therefore, indicates the possibility of invasion of the area by Teredo, but not the certainty that the latter has arrived. The occurrence of young mussels (Mytilus) on piling is also another danger-sign warning the engineer to look out for Teredo. As the result of the biological inquiry Prof. Kofoid suggests that it is necessary to restrict the uncontrolled use of untreated or unprotected timbers in marine structures, that harbours should not be used as a dumping-ground for waste wood, and that unused infected timber structures should be removed.

In a concluding summary the committee directs attention to certain other practical matters. In those parts of San Francisco Bay where the attack is severe the borers destroy untreated piling in six to eight months, but in other places untreated piling may last two to four years. A life of five to eight years may be expected from paint and batten protections if the work is well done and the covering not damaged by careless handling. Properly creosoted Douglas-fir piling, if carefully handed so that there is no injury extending through the "shell" of treated wood, may last twenty-five to thirty years, but, on account of the damage liable to occur during repeated handling, storage, and rafting, the average length of life has been considerably less. Most of the attacks on

creosoted piling observed by the committee have begun where untreated wood has been exposed by damage in handling the piles, and it is urgently recommended that care be taken to reduce such damage to a minimum. Precast reinforced concrete piles and pile-casings which have been in serv ce for ten years show no evidence of deterioration, and seem likely to be of use for a number of years to come.

Universities of Oxford and Cambridge.

Report of the Royal Commission.

THE report of the Royal Commission on the Universities of Oxford and Cambridge has been published as a Blue Book (Cmd. 1588, 6s. net), and we print below some of the more important recommendations. The Commission, which was appointed in November, 1919, under the chairmanship of Mr. H. H. Asquith, had as its object an inquiry into the financial resources of the Universities and the uses to which they were put, and in this respect the scope of the Commission was very different from those of 1850 and 1877. The immediate occasion for the appointment of the Commission was the application of the Universities for large-scale financial assistance, and the report is confined principally to this aspect of the present position of the Universities.

The first consideration is that the numbers in residence at Oxford and Cambridge have increased largely in recent years and the scope of the work undertaken has widened. As a consequence, the staffs of the Universities and colleges are heavily overworked in many cases and research is suffering. The Commissioners report that either (*a*) the number of students must be decreased, or (*b*) the staffs must be increased, or (*c*) the standard of learning must be allowed to go down.

Dealing with the new relation between science and national development, the conclusion has been reached "that technical education does not suffice. In order to get the greatest scientific results even of a practical character, investigations carried on with merely technical objects and in a merely utilitarian and commercial spirit will not achieve the highest results. The disinterested pursuit of scientific investigation affords the surest means by which the nation can ultimately command the resources of nature." For Oxford, it is suggested that a scheme should be drawn up for future scientific developments in the parks or on some other site near the Museum; for Cambridge, attention is directed to the question of establishing a central institution for training and research in surveying, hydrography, and geodesy. Light and cheaply built laboratories of one storey are also suggested for elementary work.

The financial difficulties which now threaten Oxford and Cambridge are ascribed to their great developments, and also to the change in the value of money. Reviewing possible methods of augmenting the Universities' incomes, the Commissioners are of opinion that raising fees would have the undesirable effect of turning Oxford and Cambridge into rich men's Universities. The real hope of future prosperity and development lies in private benefactions, but unfortunately there is no prospect of private benefactions being obtained sufficiently soon and in sufficient quantity to avert financial disaster. A State grant is therefore recommended, and the Commissioners state definitely that it is an absolute necessity in the public interest that an adequate grant should be made, even under the present financial conditions of the country. The report goes on:—" We recommend that each University receive, instead of the existing interim grant of 30,000*l*., an annual grant of 100,000*l*. a year, in addition to 10,000*l*. a year for special purposes (women's education and extramural work), and a lump sum for pension arrears, in order to enable them to fulfil their functions to the nation in a satisfactory manner."

The principal purposes to which the suggested grant should be devoted are as follows:—proper salaries and pensions for University teachers; the adequate maintenance of the University libraries and museums; the endowment of research and advanced teaching, including more professors, readers, and University or faculty lecturers, and more research studentships for young graduates; the most pressing needs of maintenance in respect of laboratories and departmental libraries; and the provision in both Universities of a Sites and Buildings Fund. The grants should be made to the University and not to the separate colleges.

Of the minor recommendations laid down in the report, a few only will be mentioned. Fellowships are considered to be valuable assets of the colleges, and in consequence the Commissioners recommend that Fellowships be divided into the following classes:—(*a*) Restricted to those who hold certain University posts; (*b*) Fellowships associated with official posts in the College, or with University lectureships or demonstratorships; (*c*) Old Fellows who have retired from active work; (*d*) Fellowships to which young graduates may be elected under conditions of research; and (*e*) Supernumerary Fellowships. (*b*) and (*d*) only should be stipendiary.

Dealing with pensions for members of the staffs of the Universities, the report advocates that the "federated superannuation system of the Universities" be applied, and that provision be made in College statutes for its adoption in all Colleges also, the cost to Colleges being met, if necessary, out of increased fees. It is suggested that the retiring age should be 65 for teachers and administrative officers, and 70 for heads of Colleges.

On the question of the position of women at Oxford and Cambridge the Commissioners express the opinion that ample facilities should be offered for the education of women and for their full participation in the life and work of the University. The Cambridge Committee recommend that women be entitled to be admitted on the same conditions as men to membership of the University subject to various limitations, which include the provision that the offices of the Chancellor, Vice-Chancellor, and Proctor be not open to women.

Finally, it is recommended that any facilities obtained by State grants, directly or indirectly, for the increase of College or Faculty staffs be used to secure more time for research and not to increase the provision for the individual teaching of undergraduates. It is also suggested that a central University Fund be created, assisted out of the general grants from public funds, to enable a specially qualified professor, reader, or lecturer to take a period of absence exceptionally for travel and research, without loss of income, on the recommendation of the proposed Board of Studies and Research. Both these suggestions have been made by the Commissioners with the idea of stimulating and increasing the value of research and advance work.

University and Educational Intelligence.

Leeds.—The chair of civil and mechanical engineering in the University of Leeds will shortly be vacant owing to the resignation of Prof. J. Goodman, who has held the chair since 1890. Prof. Goodman proposes to give his time to research, and the University Council has assigned to him accommodation for this purpose.

London.—Dr. C. A. Pannett has been appointed to the University Chair of Surgery tenable at St. Mary's Hospital Medical School. In 1920–21 Dr. Pannett was Hunterian Lecturer at the Royal College of Surgeons. He is the author of numerous papers on surgical operations and research.

Dr. C. A. Lovatt Evans has been appointed to the University Chair of Physiology tenable at St. Bartholomew's Hospital Medical College. He has carried out research work at the National Institute for Medical Research, at Freiburg, and at Cambridge; and is the author of numerous papers on Experimental and Chemical Physiology.

Dr. G. B. Jeffery has been appointed to the University Chair of Mathematics tenable at King's College. Since 1912 Dr. Jeffery has been Assistant in the Department of Applied Mathematics at University College, and was Acting Head of the Department from 1914 to 1917, in respect of which appointment the Senate conferred on him the title of Reader in Applied Mathematics. He has conducted research work in the Theory of Special Functions, Hydrodynamics, Elasticity, and the Theory of Relativity.

A resolution has been adopted by the Senate expressing great gratification at the establishment by the Worshipful Company of Cutlers of five Scholarships of 90*l.* a year for two years, to be awarded, on the recommendation of the Senate, to suitable candidates who have passed Part I. of the Final Examination for the B.Com. Degree and undertake to enter for Part II. These Scholarships will be "open for competition by young men of British nationality who intend to adopt a commercial, engineering, or metallurgical career, and propose to pursue the study of some foreign language or languages in France or Spain or such other country as may from time to time be approved by the Company."

The following Doctorates have been conferred:—*D.Sc. in Geology:* Mr. L. M. Parsons, an Internal Student, of the Imperial College—Royal College of Science, for a Thesis entitled "Dolomitization in the Carboniferous Limestone of the Midlands." *D.Sc. in Physics:* Miss A. C. Davies, an Internal Student, of Royal Holloway College, for a Thesis entitled "The Minimum Electron Energies Associated with the Excitation of the Spectra of Helium." *D.Sc. in Physiology:* Miss E. E. Hewer, an Internal Student, of Bedford College, for a Thesis entitled "Some Functions of the Suprarenal Glands."

Manchester.—Prof. Arthur Lapworth, who has been, since 1913, professor of Organic Chemistry in the University, has been appointed Sir Samuel Hall professor of Chemistry and Director of the Chemical Laboratories in succession to Prof. H. B. Dixon.

Prof K. H. Vickers, professor of modern history in the University of Durham (Armstrong College, Newcastle), has been appointed Principal of University College, Southampton, in succession to Prof. Loveday, now Vice-Chancellor of the University of Bristol.

Calendar of Industrial Pioneers.

March 30, 1856. Sir William Symonds died.—Entering the Royal Navy in 1794, Symonds at the conclusion of the Napoleonic wars turned his attention to naval construction and in 1825 was permitted to build the brig *H.M.S. Columbine*, the success of which led to his appointment in 1823 as Surveyor of the Navy. During the succeeding fifteen years he was responsible for the design of over two hundred vessels. He introduced various improvements leading to greater speed, more stability, and increased stowage.

March 30, 1882. William Menelaus died.—Trained in Scotland as a millwright, Menelaus rose to be engineer and manager of the Dowlais Iron Works in South Wales, where some of the earliest work was done in connection with the Bessemer process of making steel. He served as President of the Iron and Steel Institute, and in 1881 was awarded the Bessemer Medal.

March 31, 1776. John Bird died.—One of the most famous astronomical instrument-makers of the eighteenth century, Bird began life as a cloth-weaver in the north of England. Coming to London in 1740 he worked for Sisson, and with Graham's assistance in 1745 he set up in business in the Strand. He introduced improved methods of dividing instruments, and supplied mural quadrants to Greenwich and to many of the continental observatories. He also constructed the standard yard measures kept in the House of Commons till destroyed in the fire of 1834.

March 31, 1846. Andreas Kurtz died.—Born in 1781 in Reutlingen, in Wurtemberg, Kurtz as a boy found his way to Paris, where he worked in the factories and gained an intimate knowledge of practical chemistry. After Napoleon's downfall he settled in England, and erected works in Manchester, Liverpool, and St. Helens.

April 1, 1910. Frederick Wicks died.—Known as one of the pioneers in the development of rapid and accurate type-casting and composing machinery, Wicks took out his first patent in 1879, but it was not till twenty years afterwards he achieved success. In 1900 the *Times* was printed from new type supplied fresh every day from a Wicks rotary machine.

April 3, 1667. Edward Somerset, Marquis of Worcester, died.—A zealous adherent to the cause of King Charles I., Somerset after the king's fall resided in France for a time, but returning to England was confined in the Tower. At the Restoration he recovered his estates and then gave himself up to mechanical experiments. In 1663 he published his "Century of Inventions," in which is to be found his plans for a steam pump, "an admirable and most forcible way to drive up water by fire."

April 3, 1871. James Sheridan Muspratt died.—A son of the founder of the alkali industry in Lancashire, Muspratt studied under Graham and Liebig, spent some years on the continent, made various chemical discoveries, and in 1848 established the Liverpool School of Chemistry. He was the author of a standard "Dictionary of Chemistry."

April 4, 1861. Sir James Caleb Anderson died.—Anderson took out several patents in connection with steam navigation and locomotives, and was well known as one of the early experimenters with steam road carriages.

April 4, 1883. Peter Cooper died.—One of the first constructors of locomotives in the United States, Cooper had large engineering works in Baltimore, and was the founder of the Cooper Institute in New York, where some 3000 students are trained in the mathematical and natural sciences.

E. C. S.

Societies and Academies.

London.

Royal Society, March 9.—Sir Charles Sherrington, president, in the chair.—T. R. **Merton** and S. **Barratt**: The spectrum of hydrogen (Bakerian Lecture). The secondary spectrum is characteristic of pure hydrogen and feeble discharges. Impurities weaken it and enhance the Balmer series. The secondary lines are classified in different physically related groups which depend on the pressure of gas, the conditions of excitation, etc. The Balmer series appear in most celestial spectra. There is no evidence of the secondary spectrum in the solar spectrum. Measurements of the widths of the lines by a new method independent of estimates of "limiting visibility" show that the secondary spectrum is due to the molecule. When the current density of electrical discharges through vacuum tubes is great a partial separation of the gases is effected. This may have some bearing on the interpretation of certain celestial spectra. There is much evidence for a specific influence of neighbouring atoms on the spectra emitted. Helium modifies the secondary spectra of both hydrogen and carbon.

March 16.—Sir Charles Sherrington, president, in the chair.—H. H. **Dale** and C. H. **Kellaway**: Anaphylaxis and anaphylatoxins. Guinea-pigs were rendered passively anaphylactic to egg-albumin by injections two days previously of the precipitin for crystallized egg-albumin. Intravenous injection of a further dose of the same precipitin, a few minutes before a dose of egg-albumin, suppressed the anaphylactic reaction. Similarly, isolated plain muscle from anaphylactic guinea-pigs suspended in saline solution, was completely protected from the stimulating effect of egg-albumin by adding to the bath the precipitin which caused the anaphylactic condition. The toxicity of so-called "anaphylatoxins," produced by digesting serum with carbohydrate sols, etc., is due to the formation of complexes which keep the foreign colloid finely dispersed. They do not act on isolated plain muscle, as the anaphylactic antigen does, but are active only in the presence of the circulating blood. Their action is attributed to exposure of the blood to a large foreign surface.—J. C. **Bramwell** and A. V. **Hill**: The velocity of the pulse wave in man. The velocity of the pulse wave, relative to the blood in the vessel, is given in metres per second, $v=3{\cdot}57/\sqrt{\text{per cent. increase in vol. of vessel per mm. of Hg. increase of pressure}}$. An observation of the velocity therefore gives the degree of extensibility of the vessel, and is one criterion of an efficient circulation. It is shown that pressure has a considerable effect on the velocity and that the calculated velocity is less than that observed in man. This is attributed to the "elastic after-action." Experiments on an isolated human artery gave a velocity comparable with that observed in man. The transmission of the pulse wave is purely mechanical, its velocity depending on the extensibility of the vessels as modified by any condition (muscular or otherwise) pertaining at the moment.—A. **Fleming**: On a new bacteriolytic element found in tissues and secretions. A substance termed a "microzyme" found in tissues and secretions is strongly bacterio-inhibitory, bactericidal, and bacteriolytic. It is precipitated from albuminous solutions by protein precipitants, is inhibited by 1/800 normal acid or alkali, and will not pass through a collodion membrane. Filters of porcelain, cotton wool or filter paper absorb microzyme from first portion of fluid filtered, but when saturated the microzyme passes freely. Microzyme affecting *Micrococcus lyticus* is present in most tissues of the human body. Normal urine, sweat, and cerebro-spinal fluid apparently contain none, but tissues of dog, rabbit, and guinea-pig contain microzyme for *M. lyticus*. Egg-white is very potent, showing lytic action at a dilution of 1 in 50 millions, and a small amount was found in the turnip. Human secretions contain microzyme exercising lytic action on most bacteria of the laboratory air, on bacteria pathogenic for animals but not pathogenic for man, and on many cocci isolated from the human body.—J. W. **Pickering** and J. A. **Hewitt**: The action of "peptone" on blood and immunity thereto. Typical inhibition of the coagulation of the blood can be obtained by the addition of "peptone" to blood *in vitro*, in quantities no greater than those required to produce inhibition *in vivo*, provided the disturbance of the surface conditions of the blood, incidental to shedding, is sufficiently reduced. Leucocytes play no part in the anti-coagulant action of "peptone" on blood. The slow injection of maximal amounts of "peptone" into cats, with the liver out of the circulation, produces typical immunity to anti-coagulant action. A physical explanation is suggested. In the interpretation of the coagulation of the blood it is unnecessary to assume the existence of antithrombin, proantithrombin, and antiprothrombin, and current "thrombin theories" become untenable.

Geological Society, March 8.—Mr. R. D. Oldham, vice-president, in the chair.—Baron Francis **Nopcsa**: On the geological importance of the primitive reptilian fauna in the Upper Cretaceous of Hungary. The Upper Cretaceous of Eastern Hungary can be divided into two horizons, the Cenomanian, Turonian, and Lower Senonian strata, and the uppermost Senonian and the Danian formation. The Danian is a freshwater deposit that passes downwards by means of brackish-water beds into the marine strata. The vertebrate fauna of the freshwater beds has, despite its Upper Cretaceous age, a strikingly Jurassic aspect. It contains primitive tortoises, a Camptosaurian Dinosaur, a primitive Trachodon, a Sauropodous Dinosaur, an armoured Dinosaur, and a Pterosaurian. Isolation during the whole of the Cretaceous Period caused a dwarfing of the larger animals (Dinosaurs) but did not affect the smaller forms (crocodiles and tortoises). In consequence of a general uplift at the dawn of the Eocene and the cooling of the climate, nearly the whole of this fauna became extinct. Crocodiles which were adapted to a warm-blooded diet survived until the Miocene Period, and only retired to the tropics when the climate became so cold that the palms vanished from Europe.

Optical Society, March 9.—Sir Frank Dyson, president, in the chair.—T. **Smith** and J. S. **Anderson**: A criticism of the nodal slide as an aid in testing photographic lenses. The nodal slide is only convenient for the examination of lenses over their entire field when these are of normal type unless supplemented by suitable linkages. Collimators and lenses should in general be so directed that all useful light passes through them as symmetrically about their axes as possible.—A. J. **Bull**: A non-polarising spectrophotometer. Uniform monochromatic patches of colour are compared, instead of the more usual arrangement of two portions of a spectrum. The upper half of a spectrum undergoes selective absorption by the material under test, and a region of the spectrum is selected by a slit. A split lens then forms two images of the dispersing prism face which are brought together by a rhomb-like prism with slightly unequal angles. Photometric balance is obtained by

the partial closure of the lower portion of the selecting slit.—J. **Guild**: The photometry of optical instruments. A portable surface-brightness photometer of the polarisation type for the measurement of the fraction of the incident light transmitted or reflected by an optical instrument, and for the measurement of the relative brightness of different parts of a field of view was described. The instrument is a modified Wanner optical pyrometer.—T. **Smith**: A projective treatment of the submarine periscope. The optical events occurring in a periscope may be illustrated by homocentric projection. This affords a simple means of finding the relative advantages of different arrangements of the optical system.—A. J. **Dalladay**: Some measurements of the stresses produced at the surfaces of glass by grinding with loose abrasives. The stresses at the surface of a piece of "greyed" glass were measured and the relation is shown between the size of grains of the abrasive used and the stresses produced.

Linnean Society, March 16.—Dr. A. Smith Woodward, president, in the chair.—C. E. **Salmon**: (1) *Sagina filicaulis* Jord. It differs from *S. apetala* by its tapering sepals, and by their being appressed to the ripe capsule; from *S. ciliata* by being more glandular, sepals less acute, and shorter in proportion to the ripe capsule. (2) *Cerastium subtetrandrum* Murbeck. Occurs in Orkney and in W. Sutherland. It differs from *C. tetrandrum* by being both pentamerous and tetrandrous; the lower bracts are smaller than the stem-leaves, sepal tips are pointed, and seeds smaller. (3) *Arum italicum* Mill. Found in S. and S.W. England, it differs from *A. maculatum* by the petioles being much longer in proportion to the blade, spathes are longer compared with spadix, ovaries more numerous, and the spadix is differently shaped and larger.

Aristotelian Society, March 20.—Prof. G. Dawes Hicks in the chair.—R. F. A. **Hoernlé**: Some byways of the theory of knowledge. In the attempt to give scientific precision to their language, some philosophers have introduced into theory of knowledge a distinction between first-hand knowledge and second-hand knowledge (or knowledge mediated by symbols), alongside of the current distinctions between "knowledge by acquaintance" and "knowledge by description," or "immediate acquaintance" and "thought." Acquaintance and immediate experience are, in current theory, commonly characterised by absence of language and of analysis, whereas first-hand knowledge, *e.g.* a botanist engaged in research, may involve any amount of analysis and symbols. Yet there will be no divorce of description from acquaintance, or of thought from immediate data, but the data will be ordered and acquire significance, and their meaning will come to the investigator as fulfilled and realised, in a sense in which it cannot do so to one who merely reads his account at second-hand. The choice of a terminology is no mere matter of words, for it is a choice of meanings, and therefore of the qualities and relations which we affirm as "true" and "real" of the object under discussion. Definition merely leaves open the question whether anything bearing the character defined exists. The suggestion was made that a comparative and systematic study of philosophical languages is much to be desired as a preliminary to rational choice, and, in any case, as a help to mutual understanding.

DUBLIN.

Royal Irish Academy, February 13.—Prof. Sydney Young, president, in the chair.—S. **Young**: The vapour pressures and boiling points of non-miscible and miscible liquids and the composition of the vapours (distillates) from such heterogeneous and homogeneous mixtures. The formation of azeotropic mixtures of minimum and maximum boiling point was explained, and the case of ternary azeotropic mixtures was especially considered. A large number of these mixtures have been discovered since 1902, and by plotting the boiling points of known ternary and binary mixtures against the boiling points of the aliphatic alcohols it is possible to predict with some confidence whether the alcohols not yet examined will form binary azeotropic mixtures with benzene, normal hexane, or toluene, or ternary mixtures with one of these hydrocarbons and water.

MANCHESTER.

Literary and Philosophical Society, March 7.—Mr. T. A. Coward, president, in the chair.—W. M. **Tattersall**: The sound-producing mechanisms of Crustacea. Some species of Crustacea from the shallow waters and shores of East Africa and others from Australia exhibit mechanisms for the production of sound. Three main types of sound-producing mechanism are found. (*a*) Popping Type: The sound is produced by the rapid withdrawal of a tightly fitting peg from a socket. (*b*) Fiddle and Bow Type. Rapid motion of a sharp smooth ridge or a row of granules across a row or series of rows of regularly arranged granules or tubercles or a file-like series of ridges or *vice-versa* produces the sound. (*c*) Plectrum Type. Two series of stiff, hollow spines are rubbed together. The first type is found in the snapping shrimps (Alpheus) characteristic of coral reefs; the second type in the spiny lobster of British coasts, some shore crabs from tropical waters like Matuta, Platyonichus, Pseudozius and the amphibious crabs, Ocypoda and Uca; and the third type only in certain river crabs in Africa. The stridulating organs occur in both sexes. The sound is probably a warning-note to keep intruders from a burrow already occupied.

Official Publications Received.

Département van Landbouw, Nijverheid en Handel. "'S Lands Plantentuin" ("Jardin Botanique de Buitenzorg"). Treubia. Recueil de travaux zoologiques, hydrobiologiques et océanographiques. Rédigé par Dr. W. M. Docters van Leeuwen, Dr. K. W. Dammerman et Dr. A. L. J. Sunier. Vol. 2, Livraison 1, Décembre. Pp. 155. (Buitenzorg: Archipel Druckkerij.)

The Indian Forest Records. Vol. 8, Part 3: The Beehole Borer of Teak: A Preliminary Note on the Ecology and Economic Status of *Duomitus ceramicus*, Wlk. in Burma. (*Lepidoptera, Cossidæ.*) By C. F. C. Beeson. Pp. iii+105+3 diagrams. 3 rupees. Vol. 8, Part 4: Notes on Artificial Regeneration in Bengal. By A. K. Glasson and others. Pp. iii+33+11 plates. 2 rupees. (Calcutta: Government Printing Office.)

Carnegie Institution of Washington. Year Book No. 20, 1921. Pp. xxii+475. (Washington.)

Records of the Botanical Survey of India. Vol. 8, No. 3: Flora Arabica. By Prof. E. Blatter. Part III: Campanulaceæ-Verbenaceæ. Pp. ii+283-365. 1.1 rupee. Vol. 9, No. 1: A Survey of the Flora of the Anaimalai Hills in the Coimbatore District, Madras Presidency. By C. E. C. Fischer. Pp. ii+218+xxi. 4.4 rupees. Vol. 9, No. 2: Euphorbiaceæ Novæ e Peninsula Malayana. By A. T. Gage. Pp. ii+219-250. 8 annas. (Calcutta: Government Printing Office.)

Report of the Proceedings of the Fourth Entomological Meeting held at Pusa on the 7th to 12th February 1921. Edited by T. Bainbridge Fletcher. Pp. xii+401. (Calcutta: Government Printing Office.) 7.8 rupees.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 8: Het Klimaat van Nederlandsch-Indië (The Climate of the Netherlands Indies). By Dr. C. Braak. Deel 1 (Vol. 1): Algemeene Hoofdstukken (General Chapters), Aflevering 2 (Part 2); With English Summaries. Pp. iii+65-147+50. (Batavia.)

The Rockefeller Institute for Medical Research. Organization and Equipment. Pp. 25. (New York.)

Library of Congress. Report of the Librarian of Congress and Report of the Superintendent of the Library Buildings and Grounds, for the Fiscal Year ending June 30, 1921. Pp. 207. (Washington: Government Printing Office.)

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. Isforholdene i de Arktiske Have (The State of the Ice in the Arctic Seas) 1921. By Kapt. C. I. H. Speerschneider. Pp. 32+5 maps. (Kjøbenhavn: G. E. C. Gad.)

Diary of Societies.

FRIDAY, March 31.

Association of Economic Biologists (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Dr. W. L. Balls: Advantages and Defects of Team Work in Economic Biology.—Dr. F. Kidd: Problems of Fruit Storage.
Institution of Mechanical Engineers, at 6.—Prof. H. H. Jeffcott: The Milling of Screws, and other Problems in the Theory of Screw-threads.
Institution of Electrical Engineers (London Students' Section), at 7.—J. S. Highfield: Presidential Address.
Institution of Aeronautical Engineers (at Royal Society of Arts), at 7.30.—Mr. Folland: Aircraft Design.
Junior Institution of Engineers, at 8.—D. P. Dickinson: The Steel Melting Shop.

SATURDAY, April 1.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: Radioactivity (5).

MONDAY, April 3.

Royal Institution of Great Britain, at 5.—General Meeting.
Royal Society of Arts, at 8.—G. Radcliffe: The Constituents of Essential Oils (Cantor Lectures), (3).
Society of Chemical Industry (London Section), (at Chemical Society), at 8.
Royal Institute of British Architects, at 8.—S. C. Ramsey: London Clubs.

TUESDAY, April 4.

Royal Institution of Great Britain, at 3.—Dr. J. W. Evans: Earth Movements (2).
Royal Society of Arts (Dominions and Colonies Section), at 4.30.—Sir Thomas Bilbe Robinson: New Zealand.
Royal College of Physicians of London, at 5.—Dr. H. Mackenzie: Diseases of the Thyroid Gland (2).
Zoological Society of London, at 5.30.—C. Tate Regan: Exhibition of lantern-slides illustrating Blind Fresh-water Fishes from Caves.—Dr. J. T. Cunningham: Mendelian Experiments on Fowls. III. Production of Dominant Pile Colour.—Dr. M. Khalil: A Revision of the Nematode Parasites of Elephants, with a description of four new Species.
Institution of Civil Engineers, at 6.—Sir Robert A. Hadfield, Bart.: Corrosion of Ferrous Metals.
Röntgen Society (at Institution of Electrical Engineers), at 8.15.

WEDNESDAY, April 5.

Institution of Electrical Engineers (Wireless Section), at 6.—Capt. J. H. Whittaker-Swinton: Provision of Power for Wireless Telegraphy.
Society of Public Analysts and Other Analytical Chemists (at Chemical Society), at 8.—O. D. Roberts and H. T. Islip: The Constants of Indian Beeswax.—A. Chaston Chapman: Note on the Liver Oil of the "Tope" (*Galeus galeus*).—A. Chaston Chapman: Note on the Examination of Foods for the Presence of Sulphites.—S. H. Groom: Demonstration of Artificial Daylight for Laboratory Purposes (Sheringham System).—A. Bruce: A Tropical Milk Supply.—E. R. Bolton and D. G. Hewer: Certain Tropical Oilseeds.
Royal Society of Arts, at 8.—Prof. E. R. Matthews: Sea Encroachment and its Prevention.
Entomological Society of London, at 8.

THURSDAY, April 6.

Royal Institution of Great Britain, at 3.—Prof. A. M. Hind: Landscape Etchers: New and Old (2).
Royal Society, at 4.30.—*Probable Papers*.—F. E. Smith: An Electromagnetic Method for the Measurement of the Horizontal Intensity of the Earth's Magnetic Field.—G. I. Taylor: Stability of a Viscous Liquid contained between two Rotating Cylinders. Part I. Theoretical. Part II. Experimental.—Prof. T. H. Havelock: Dispersion Formulæ and the Polarisation of Scattered Light: with Application to Hydrogen.—Dr. G. R. Goldsbrough: The Cause of Encke's Division in Saturn's Ring.—C. Spearman: Correlation between Arrays in a Table of Correlations.—Dr. W. L. Balls: Apparatus for determining the Standard Deviation Mechanically.
Royal College of Physicians of London, at 5.—Dr. H. Mackenzie: Diseases of the Thyroid Gland (3).
Linnean Society of London, at 5.—Dr. A. B. Rendle: An Example of Regeneration of the Terminal Bud.—C. Turner: The Life-history of *Staurastrum Dickiei*, var. *parallelum* (Nordst.).—L. C. Borradaile: The Mouth-parts of the Shore-crab, with lantern-slides.
Royal Aeronautical Society (at Royal Society of Arts), at 5.30.—L. Brèguet: Aerodynamical Efficiency and the Reduction of Air Transport Costs.
Child Study Society (at Royal Sanitary Institute), at 6.—M. Yearsley: A Plea for the Deaf Child.
Institution of Electrical Engineers, at 6.—J. A. Kuyser: Protective Apparatus for Turbo-Alternators.
Chemical Society, at 8.—Prof. M. O. Forster and W. B. Saville: Constitution of Picrorocellin, a Nitrogenous Constituent of *Roccella fuciformis*.—S. Sugden: The Determination of Surface Tension from the Maximum Pressure in Bubbles.
Civic Education League (at Leplay House, 65 Belgrave Road, S.W.1), at 8.15.—Miss M. M. Barker: Occupational Education.

FRIDAY, April 7.

Diesel Engine Users' Association (at Institution of Electrical Engineers), at 3.—H. Moore: Some Characteristics of Petroleum Oil used in Diesel Engines.
Royal Aeronautical Society (Students' Section) (at 7 Albemarle Street), at 6.45.—Prof. L. Bairstow: Some Aeronautical Problems of the Early Future.
Junior Institution of Engineers, at 8.—J. W. Maple: Engineering in Southern Persia.
Royal Institution of Great Britain, at 9.—Sir Ernest Rutherford: Evolution of the Elements.

SATURDAY, April 8.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: Radioactivity (6).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

SATURDAY, April 1.

Polytechnic (Regent Street, W.1), at 10.30 a.m.—Prof. H. E. Armstrong: The Wonders and Problems of Food.
Horniman Museum (Forest Hill), at 3.30.—Dr. W. A. Cunnington: Woman's Sphere in Savage Africa.

WEDNESDAY, April 5.

School of Oriental Studies, at 12.—Miss Alice Werner: Bantu Mythology and Folk Lore (6).

CONTENTS.

NATURE

SATURDAY, APRIL 8, 1922.

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The Development Fund.

IN a recent leading article (NATURE, February 16) on the subject of the Geddes Report in its relation to Education and Research, allusion was made to the seemingly precarious condition of the above Fund. While it is a matter for congratulation that the Chancellor of the Exchequer, agreeing with the views which we expressed, rejected the suggestions that the funds provided by Parliament for *additional* research should be used to fill a gap to be created in *existing* expenditure, he did nothing to allay the anxiety created by the depletion of the Development Fund. A White Paper (No. 15, price 3*d.* net) just published contains the accounts of this Fund for the year ended March 31, 1921. It appears that the surplus at the credit of the Fund on that date was 1,170,000*l.*; but of this about one-third represents outstanding loans, and the amount available for current needs on April 1 of last year was only 795,000*l.* Referring to the Report of the Commissioners for the same year we find it stated that "against this balance must be set liabilities . . . in respect of advances recommended up to that date . . . there was a balance, therefore, of 250,000*l.* for annual advances required to meet the *cost of existing* schemes."

The published accounts show that in the year 1920–21 alone advances totalling 568,000*l.* were made, and, so far as it is possible to interpret the accounts, at least 300,000*l.* of this sum was required to meet the recurrent cost of existing schemes. It seems doubtful, therefore, whether the balance available on April 1 of last year was sufficient to meet the normal liabilities of the Fund for the succeeding twelvemonths. There is, however, a reserve not disclosed in the accounts, for in their Report the Commissioners go on to say: "In the estimates . . . for the following year (1920–21) Parliament voted a similar amount [1,000,000*l.*] for the general purposes of the Development Fund. In view of the urgency of restricting issues from public funds, the Commissioners agreed that the grant voted should be surrendered . . . on the understanding that Parliament would be invited to revote the amount in the year 1922–23." But in the statements that have been published from time to time in connection with the economy campaign, this sum of one million has not been specified. It is to be hoped that when Parliament is "invited" to provide the money it will be realised that, without it, the whole organisation of research in the sciences bearing on agriculture and fisheries must collapse.

With the help of the Development Fund a number of research institutions have been established on a permanent basis, and yet there is no guarantee that the money required for their maintenance will be forthcoming even one year hence. Under our Constitution no continuing guarantee can be given, but it might be considered whether greater stability would not be secured by transferring the liability for all permanent schemes to a regular vote head, thus leaving the Fund for real "development" purposes.

The Teaching of Physics.

AT the Orono meeting of the New England section of the Society for the Promotion of Engineering Education held recently, the question was discussed, "What is the matter with physics teaching?" We have received two of the opening papers, from which it appears that in American technical colleges and universities, engineering students dislike and even despise the physics taught them. For this the teacher is blamed, on one hand for not being sufficiently precise and exact in his definitions and reasoning, and on the other for trying to force on the engineer the C.G.S. system of units. Most of the illustrations of bad teaching are taken from dynamics, an accurate knowledge of which is, of course, indispensable to the really scientific engineer.

The trouble is also traced to some extent to the academic text-book, which teems with artificial problems having little relation to what is met with in practice. Students whose minds are gripping the mechanism of water-wheels, pumps, and engines are too often expected to find satisfaction in the study of levers, "simple machines," and systems of weightless and frictionless pulleys. It appears, moreover, that the text-book is being more and more neglected, and, as one writer puts it, "physics has degenerated into interminable class-room coaching, making our teaching

not only very exhausting, but also frightfully expensive, and greatly weakening the *moral* of our students."

There is certainly an element of truth in this criticism. In many universities students get so much direct teaching by lecture, by tutorial expansion, and by the performance of routine experiments to printed orders, that they have little time or energy left for real effective thinking. There is a tendency to forget that a mere knowledge of apparatus and of methods of experimenting does not make a physicist. The physical imagination should be trained, and the highest powers of mind called into play, and the student should be encouraged to get into living touch with the creative literature of the subject. This, of course, is not easy, especially when the classes are large. What is wanted is an accessible reading-room fully supplied with the journals and other publications in which progressive work is recorded. Students, if not overburdened by an excess of class and laboratory attendance, would soon come to appreciate the value and delight of thus getting into touch with the vital problems of the day.

Nevertheless, in the hands of a good teacher there is nothing to compare with the lecture as a means of giving a systematic theoretic view of the whole science treated, and there is no better corrective to the extreme and unscientific utilitarianism which makes many a student think that he is being taught what will be of no value to him. Technical schools may narrow their teaching to what seem at the time to be the absolute necessities, but a university is intended to give engineering students an all-round training in the fundamental sciences of mathematics, natural philosophy, and chemistry. Without these an engineer is only half equipped for his calling.

The Principles of Distillation.

Distillation Principles and Processes. By Prof. Sydney Young, with the collaboration of various authors. Pp. xiv+509. (London: Macmillan and Co., Ltd., 1922.) 40s. net.

THIS book is a new and amplified edition of the author's well-known treatise on "Fractional Distillation," first published in 1903. Prof. Sydney Young is an acknowledged authority on the subject on which he writes, and for many years prior to the appearance of the first edition of his work, the principles underlying the separation of substances by distillation had been investigated by him and the results communicated to various scientific societies. But his book embodied not only his own experience. Everything that was known at that period concerning the science and art of distillation was duly recorded and discussed, and the relative merits of the various still-heads and other forms of apparatus employed in the processes of fractional distillation were carefully inquired into and compared. The rapid development of organic chemistry, pure and applied, during the latter half of the nineteenth century was the immediate cause of the attention which the subject then received. Distillation was practically the only means available for the isolation of the constituents of mixed liquids. The art of distillation is, of course, as old as any chemical process, but the principles upon which its efficient application as a method of separation of complex liquids depend, were very imperfectly understood. Prof. Young's book was the first systematic attempt to explain these principles and to illustrate their bearing upon laboratory and technical procedure. It has not only been of great use to operative chemistry, but it has served to indicate many points of theoretical interest concerning the thermal behaviour of substances which, although they may have no immediate utilitarian value, are certain to influence practice in the future.

During the two decades which have elapsed since the appearance of the first and second editions of this work, a considerable body of additional information has been accumulated concerning its subject-matter, not, perhaps, so much in the elucidation of fundamental principles as in the compilation of accurately observed thermal values upon which the various mathematical formulae which seek to generalise the facts of distillation depend. The present edition differs from its predecessor in one important feature: it deals more particularly with the technical applications of distillation. The book, in fact, is divided into two main sections. The first is practically a reprint of the first edition on "Fractional Distillation," extended and brought up to date by the inclusion of all material facts which have been made known during the last twenty years. For much of this information we are indebted to British workers, and the results of the valuable investigations of Wade and Finnemore and of Wade and Merriman are described in adequate detail. Wade's unfortunate death in the full tide of his intellectual vigour, when all his energies were concentrated upon the development of an inquiry with which by training and aptitude he was specially fitted to cope, was a serious loss to science.

An important addition to the work is a chapter on sublimation. As the author points out, there is no essential distinction between distillation and sublimation, although at first sight the dissimilarity of the two operations would seem to imply a difference. The term distillation denotes the volatilisation of a substance and its condensation and recovery, drop by drop: by sublimation is usually understood the direct passage from the gaseous to the solid state without

intermediate liquefaction. But intermediate liquefaction may be induced by pressure. If, therefore, the process be effected under pressure, liquefaction will occur and the substance will ultimately boil, although on cooling the vapour may pass directly to the solid state. The conditions under which distillation and sublimation become identical operations were first explained by James Thomson, though even now the triple point pressures of only a few substances are accurately known. Indeed, there is ample room for a more extended investigation on the relation of this factor to the other thermal constants of a body. The author describes very shortly a few typical cases of sublimation, such as iodine, sulphur, arsenious oxide, and ammonium chloride, with illustrations of the plant employed, and explains the principles involved in the several instances. As these are not usually indicated in text-books, the attention of teachers may well be directed to them.

The second section of the book, dealing with certain technical and large-scale operations of distillation, occupies about half the volume, and the examples selected for description have been entrusted to chemists with practical experience of their working. They comprise:

(1) Distillation of Acetone and *n*-Butyl Alcohol on the Manufacturing Scale. By Dr. Joseph Reilly and the Hon. F. R. Henley.

(2) Distillation of Alcohol on the Manufacturing Scale. By the Hon. F. R. Henley and Dr. Reilly.

(3) Fractional Distillation as applied in the Petroleum Industry. By James Kewley.

(4) Fractional Distillation in the Coal-Tar Industry. By Dr. T. Howard Buller.

(5) The Distillation of Glycerine. By Lieut.-Col. E. Briggs.

(6) The Distillation of Essential Oils. By Thos. H. Durrans.

These, it will be seen, comprise all the main technical processes with which British chemists, at least, are concerned.

Considerations of space preclude any detailed account of these several sub-sections. The descriptions are such as will appeal to the chemical engineer or works-manager. They are concise, and deal mainly with the practical aspects of the various processes, and the illustrations—chiefly in the form of line-drawings—of the plant employed, will commend themselves to those actually interested in the different industries. There is, as might be anticipated when several writers are concerned with the application of the same physical principles, a certain amount of repetition and overlapping. This is unavoidable, and is not to be deprecated even although these matters are adequately dealt with in the theoretical section of the work. Their restatement, in fact, is required in any adequate account of their bearing upon the particular technical process described.

The book is remarkably free from typographical errors, and we have noticed only a few mistakes—mainly in the spelling of proper names: thus Speyer (p. 29) should read Speyers, and Dufton (p. 138) is erroneously printed Dutton. The work indeed is a credit to all concerned in its production, and well sustains the position it already holds as the chief authority on the subject of distillation. In its present extended form it affords an admirable illustration of the benefits which follow the intelligent application of physical principles to chemical processes on a manufacturing scale.

Mathematical Analysis.

(1) *The Theory of Functions of a Real Variable and the Theory of Fourier's Series.* By Prof. E. W. Hobson. Second edition, revised throughout and enlarged. Vol. 1. Pp. xvi+671. (Cambridge: At the University Press, 1921.) 45*s.* net.

(2) *Introduction to the Theory of Fourier's Series and Integrals and the Mathematical Theory of the Conduction of Heat.* By Prof. H. S. Carslaw. Second edition, completely revised. Vol. 1, *Fourier's Series and Integrals.* Pp. xi+323. (London: Macmillan and Co., Ltd., 1921.) 30*s.* net.

(3) *A Treatise on the Integral Calculus, with Applications, Examples, and Problems.* By J. Edwards. Vol. 1. Pp. xxi+907. (London: Macmillan and Co., Ltd., 1921.) 50*s.* net.

(1) THE first edition of Prof. Hobson's treatise fell naturally into two parts. The first five chapters were occupied with the theory of aggregates, the general theory of functions, and the theory of integration, while the last two dealt with the theory of series, and in particular with Fourier's series. It is the first five chapters which have developed into the present volume. It was inevitable that a great deal of the book would have to be rewritten, for the theory has developed very rapidly; there was a mass of recent research to be incorporated, and much of the older work has been definitely superseded. The preparation of a new edition must have been a very long and heavy piece of work, and Prof. Hobson is to be congratulated on the progress he has made with so formidable a task.

There is a singular contrast between the two great branches of the theory of functions. The complex theory has always been popular. The power of its weapons is obvious; its methods have a striking, if

somewhat illusory, simplicity; and it is fascinating to investigators, to teachers, and to students alike. It is unlikely that the real theory, more abstract and in many ways more difficult, will ever be so generally attractive. Still, times have changed, very largely through the influence of Prof. Hobson himself. The theory is studied seriously even in England, and ignorance of fundamentals is no longer regarded as proof of physical insight or geometrical intuition. Prof. Hobson has every right to be satisfied with his share in this salutary revolution.

It must be admitted that there was some excuse for the conservative mathematician of twenty years ago, and his sneers at a theory which he was too lazy to try to understand. The older theory, the theory of 1900, was not only abstract and difficult, but in some ways really unattractive. There was too little simple and positive doctrine, too many intricate and irritating exceptions. Little could be proved, and the theorems which it was possible to prove were difficult to state in a terse and striking form. The theory of content in particular was obviously imperfect. The theory as a whole seemed dried up and infertile; it is easy to see now how grievously it stood in need of some refreshing storm.

All this has been changed by the rejuvenating influence of the ideas of Borel and Lebesgue. The storm has broken, and the ground has become fresh and fertile once more. There is, indeed, no other region of pure mathematics that has experienced so drastic a revolution. Prof. Hobson's book is the only English book which contains a systematic statement of the revolutionary doctrine, and it is this, above all else, that gives it its unique position.

The importance of the new theories of measure and integration is generally admitted, but their effect on the theory of functions is still very widely misunderstood. They are much more general than the older theories, and it is supposed that, being more general, they must be much more complicated and more difficult to understand. The result is that many mathematicians are too frightened to make any serious attempt to comprehend them. This attitude of panic is based on a complete misapprehension. It is not true that the new theories are much more difficult than the old. It is by no means always the most general and the most abstract that is the most difficult to understand. The trouble with the older theory lay not so much in the inherent difficulty of the subject-matter as in the complexity and clumsiness of the results. The modern theory, in acquiring generality, has acquired symmetry, terseness, and to a great extent simplicity as well. It possesses the æsthetic qualities that are characteristic of a first-rate mathematical science. Its theorems can be stated in a concise and arresting form, and make that appeal to the imagination which enables them to be mastered and remembered. It is much easier to be a master of the new theories than it was to be a master of the old, and it is also much more necessary. A young mathematician who elects to remain in ignorance of them is certain to regret his laziness or obstinacy in years when it is more difficult to learn.

It is, then, Prof. Hobson's chapters on measure (chap. 3) and integration (chaps. 6-8) that are unquestionably the most important in the book. His treatment is much more comprehensive and encyclopædic than that of any other writer. He has three serious rivals, de la Vallée Poussin, Carathéodory, and Hahn. Hahn may be disregarded for the present, as the second volume of his "Theorie der reellen Funktionen," in which the theory of integration is to be developed, has not yet appeared. The works of de la Vallée Poussin ("Cours d'analyse infinitésimale," second and third editions, 1909, 1912, 1914; "Intégrales de Lebesgue, fonctions d'ensembles, classes de Baire," 1916) continue to provide the best introduction to the theory. Between Carathéodory and Prof. Hobson it is unnecessary to discriminate, for both are essential for the systematic study of the subject. It is sufficient to say that there is a great deal in this volume which Carathéodory does not touch.

Chaps. 1, on number, and 4, on transfinite numbers and order-types (chap. 3 of the first edition) have not been greatly changed. We must confess that it has always been this part of the book that we like the least. Prof. Hobson often allows himself to use language which suggests the Oxford philosopher rather than the Cambridge mathematician. "The mind" maintains its position in the first sentence of chap. 1; "objects for thought" are "postulated" on p. 29; a "fundamental difference of view on a matter of Ontology" is mentioned on p. 249. We have an uneasy feeling that if one scratched the mathematician one might find the idealist, and that all these discussions, and especially those which concern the "principle of Zermelo," ought to be stated in a sharper and clearer form.

Chaps. 2 and 3 are concerned with sets of points, the theory of content and measure having very wisely been separated from the descriptive theory. The greatest difficulty is to distinguish the theorems for which Zermelo's axiom is required. We could make some criticisms of detail—we found difficulty, for example, in disentangling the proof that the measure of a measurable set satisfies the postulate (3) of p. 159, tied up as it is with the corresponding proof for

the more difficult postulate (4)—but it would be ungracious to insist on such small criticisms of the most comprehensive presentation of the theory.

In chap. 5, on functions of a real variable (chap. 4 of the first edition), there are very many important additions. The ideas of absolute (p. 276) and approximate (p. 295) continuity are introduced. The treatment of functions of bounded variation (we are glad to find Prof. Hobson now adopting the ordinary language) has been materially simplified, and there is a new section (pp. 318-320) on rectifiable curves. The latter part of the chapter includes an account of some of the most recent work of Denjoy, G. C. Young, and W. H. Young concerning derivatives. Above all, there is a discussion of implicit functions, omitted somewhat unaccountably from the earlier edition. This is a most welcome addition, but we are surprised that Prof. Hobson does not state the fundamental theorem (p. 407) in its most general form. No reference to derivatives is necessary, as was made clear by Young, and a theorem more general than Prof. Hobson's is to be found in so elementary a book as the reviewer's "Pure Mathematics."

Finally, chaps. 6-8 contain the theory of integration, and it is here that we find the most that is new. These chapters are naturally far better than the corresponding parts of the first edition, both in completeness and in logical arrangement, for the first edition appeared at the awkward moment when Lebesgue's ideas were new, and the consequences of his work had not been developed to their conclusion. It may be questioned whether the space (eighty pages) devoted to the Riemann integral is not excessive, since so much of the theory is now of historical or didactic interest only; but Prof. Hobson's object is, of course, to be complete. The importance of the Stieltjes integral is fully recognised in this edition. The last chapter ("Non-absolutely convergent integrals"), dealing as it does with the extreme limits of generalisation of which, in the hands of Denjoy and of Young, the notion of an integral has so far proved to be capable, is very heavy reading; but to have given the first systematic account of these generalisations is in itself a most important achievement.

It is to be hoped that we shall not wait long for the appearance of the second volume, and the completion of a work which has added so much, not only to the personal reputation of the author, but to the status of English mathematics.

(2) Prof. Carslaw's book was conceived on a much less ambitious scale than Prof. Hobson's, but he too has had to rewrite it and turn one volume into two. This first volume contains pure mathematics only, and there is no reference to any physical phenomenon after the introduction. It is, in short, a treatise on analysis, restricted within certain limits, and written with a special end in view.

Prof. Carslaw confines himself quite rigidly and consistently within the limits which he has chosen. It was necessary to have definite limits, but we do not agree entirely with his judgment in selecting them. We think that he has made them too narrow, and that he would have written a still better and more attractive book if he had allowed himself a rather wider scope. It is a very good book even as it is, for it is accurate and scholarly, it contains a mass of most interesting and important theorems which it would be difficult to find collected in an equally attractive form elsewhere, and it is written in an admirably clear and engaging style. It also contains an excellent bibliography of the subject.

Prof. Carslaw has gone too far, however, in his anxiety to eliminate the refinements of the modern theory of functions. For example, the notion of a function of bounded variation is quite explicitly and deliberately excluded (p. 207). The only functions admitted—if we confine our attention, for simplicity of statement, to bounded functions—are those which satisfy Dirichlet's famous condition; they have at most a finite number of maxima and minima within the interval considered. Now there is a serious logical objection to a treatment of Fourier's series in which this class of functions is taken as fundamental, an objection which even a physicist might feel. It is an artificial and not a natural class, since it does not form a group for the elementary operations. Neither the sum nor the product of two functions of the class is in general a function of the class; and it is difficult to see why, if a physicist is interested in two functions, he should not also be interested in their sum.

Prof. Carslaw alludes to the notion of bounded variation as "somewhat difficult," and so, no doubt, it is. But the necessary analysis, as presented, for example, by de la Vallée Poussin, is certainly not more difficult than a good deal which Prof. Carslaw includes. It is not more difficult, for example, than the second mean value theorem, or the theory of Poisson's integral, or Pringsheim's discussion of Fourier's double integral, of all of which Prof. Carslaw gives a very careful account. In any case a book may be made much easier by the inclusion of a difficult theorem, if it helps to elucidate the theorems which the book already contains.

It is inevitable that an analyst, reading a book like this, should be longing to go further all the time. No account of the theory of Fourier's series can possibly satisfy the imagination if it takes no account of the ideas of Lebesgue; the loss of elegance and of simplicity

of statement is overwhelming. We recognise that it would be unreasonable to ask Prof. Carslaw for an account of the modern theories of integration. We hope, however, that, when next he has an opportunity of preparing a new edition, he will remedy the omission which we have emphasised. He should also certainly include the fundamental theorem that the Fourier constants of any integrable function tend to zero (a rather startling omission), and some account of Parseval's theorem. He would thus add greatly to the value of an already valuable book.

(3) Prof. Hobson gives us the mathematics of 1921, and Prof. Carslaw is not far behind him. Mr. Edwards's book may serve to remind us that the early nineteenth century is not yet dead. He directs our attention to "the admirable and exhaustive works of Legendre, Laplace, Lacroix, Jacobi, Serret, Bertrand, Todhunter, etc."; from which he has learnt, for example, that "a limit may be of finite, infinite, or indeterminate value," that "the processes of integration are necessarily of a tentative nature," and that any convergent series may be integrated term by term. Two proofs are offered of the last proposition. In the first it is stated to be valid "provided the series V itself, and the series V formed by the integrations of the separate terms, are both *absolutely convergent*." Mr. Edwards italicises the last condition, but we have no idea why it is inserted, for there is no pretence of making any use of it, nor is its meaning explained.

It is difficult for a reviewer to know what to say about such a book, except that it cannot be treated as a serious contribution to analysis. Twenty years ago it might have been necessary to establish the point in detail; it would be waste of time now, when the battle for accuracy has been won. There is always the danger, however, that a student who reads a text-book may suppose that the statements which it contains are true. We should therefore state explicitly that the "general theorems" asserted in this book are often false, and that, even when they are true, the arguments by which they are supported are generally invalid.

One ought, of course, to judge the book by a different standard, as a storehouse of formulæ useful for instructional purposes. Of such there is an abundance, including a good many which are seldom found in other books, and often entertaining or even important. We may mention Catalan's formula for the surface of an ellipsoid, results concerning roulettes and glissettes, the theorems of Fagnano, Burstall, Graves, MacCullagh, Schulz, and others. The book, in short, may be useful to a sufficiently sophisticated teacher, provided he is careful not to allow it to pass into his pupil's hands.

G. H. Hardy.

Greek and Arab in Medicine.

(1) *Greek Medicine in Rome: The FitzPatrick Lectures on the History of Medicine delivered at the Royal College of Physicians of London in* 1909–10, *with other Historical Essays.* By Rt. Hon. Sir T. Clifford Allbutt. Pp. xiv+633. (London: Macmillan and Co., Ltd., 1921.) 30*s.* net.

(2) *Arabian Medicine: Being the FitzPatrick Lectures delivered at the College of Physicians in November* 1919 *and November* 1920. By Prof. Edward G. Browne. Pp. viii+138. (Cambridge: At the University Press, 1921.) 12*s.* net.

SINCE the great revival of historic interest in the eighteenth century the labour of historians has been directed mainly towards political institutions. Sociological and cultural history have been of much slower growth, and we are only now beginning to be able to treat the history of European life as a whole, to look upon it as one majestic panorama developing from the early Mediterranean culture in which first Egypt, then Crete, then Greece was leader, to the time when Rome herself, in receipt of tributary streams from Syria, Persia, Mesopotamia, and India, acted as the cultural intermediary to the European peoples, and, finally, to the diffusion by those peoples of the infectious elements of the ancient tradition throughout the world. It will thus one day become possible to present this panorama with its various aspects in adequate relation to each other. Mr. Marvin, in his "Living Past," and Mr. Wells, in his "Outline of History," have produced tentative sketches in that direction. Such works point to a time when the history of civilisation, the most absorbing of all topics, will form the humane basis of education. There are, however, large departments in which the material is not yet to hand for this consummation. Especially defective is our record of certain aspects of the development of thought. Formal thought, philosophy, has, it is true, found fairly adequate treatment. A real history of religion is, however, still strangely absent, despite the vast literature which professes to deal with that topic, and the history of psychology is very backward. The history of science, too, presents vast gaps which are sometimes vainly treated as though they represented breaches in continuity of the phenomena rather than breaches in our knowledge, and the two works before us represent the efforts of two eminent scholars in two separate departments to establish continuity across these gaps.

(1) Sir Clifford Allbutt has been distinguished for two full generations and more as an exponent alike of modern scientific medicine and of the scientific

record of Greek antiquity. He brings to this volume, the title of which gives but an inadequate idea of its range, an extent of combined knowledge and experience in these departments that is probably unsurpassed by any other man living.

About half of the book, and this probably the more valuable half, deals with the period of creative activity of the Greek genius. Sir Clifford Allbutt pictures, as perhaps only one of his attainments could, the rise of scientific medicine among the Ionian philosophers of the sixth and fifth centuries before the Christian era, and that process of "separation of medicine from philosophy" which made "science" possible. The earlier philosophers set out to give a picture of the universe both internal and external. They failed because they had not as yet concentrated on the parts which go to make the whole. But their attempt corresponded to an eternal necessity of the human mind. Two and a half millennia have passed. Mankind is now overwhelmed with a vast record in which the details of the parts prevent any vision of the whole. Science, philosophy, and history are each split into a hundred special departments, most of them without adequate relation to the others. Eternal necessity asserts itself again, and the human mind calls for attempts at synthesis. The wheel has turned full circle, and the philosophical, the educational, and the scientific demands of the day echo those needs that Thales sought to satisfy six hundred years before the Christian era.

Sir Clifford Allbutt paints on a big canvas and with the great, sure, sweeping lines that come only to those who have lived a long, full life. His work stands alone in the English language as an attempt to portray, both in outline and detail, the development as a continuous whole of Greek biological and medical thought from its early beginnings to its spread to the confines of the Roman Empire, and to its strange transformation by the new point of view introduced by the decay of the pagan political system and the rise of Christian theology.

This is a high theme which can no more be abstracted by the reviewer than can that of a great epic. The work, like every epic, contains inequalities on which it would be alike ungracious and unnecessary to dwell. But it also contains characteristic and inspiring flashes that often raise it to the level of poetry and make it a real addition to English literature. Not the least characteristic and inspiring of these is Sir Clifford Allbutt's treatment of the idea of inspiration itself and its relation to the ancient doctrine of the *pneuma*.

"To-day," says the author, "as we utter the word *inspiration* we still feel the glow of the spirit which, from the ancient legends of the creation of life to the passages of our modern ethereal telegraphy, from the hauntings of the Great Spirit in primeval man, through the storms of superstition, to the haven of the soul in its purest communion with the Divine, has moulded the whole story of man and embedded itself in his tongue. Yet we shall observe again nevertheless in the history of this, as of all spheres of thought, how a living idea gradually becomes so imprisoned in the letter that its liberty is enthralled in its own formulas. Thus as the brilliant Ionian atomic hypothesis dried up into the arid formulas of the Methodists, as Hippocratean wisdom into Dogmatism, as Empiricism into mere rule of thumb, rational scepticism into Pyrrhonism, so the idea of the pneuma was cribbed in the sectarian Pneumatism."

Sir Clifford will soon be entering his eighty-seventh year, but the vigour of this and many other passages in his remarkable book gives good hope that we may expect much further material from his pen, on topics which he, more than any other living man, is capable of treating with full adequacy.

(2) The learned Sir Thomas Adams professor of Arabic in the University of Cambridge takes up the tale where Sir Clifford Allbutt leaves off. With the fall of the Western Empire Greek science remained in the keeping of the East, and it became progressively orientalised with those changes in the outlook of the Eastern world that may be described as *Byzantinisation*. With the spread of Christianity, and with the advent of schism within the Christian Church, Greek science moved yet further east, and, in its medical aspects, at any rate, was cultivated especially by teachers of the Nestorian sect, by whom much Greek material was turned into Syriac. It was through such oriental versions that Greek medicine passed to the keeping of the Arab-speaking world. The overflow from the Arabian peninsula in the seventh century, and the conquest by the Arabs of the whole of the Near East and the whole of North Africa, the Mediterranean islands, Spain and Southern Italy in the centuries which followed, form one of the most dramatic chapters in world history. The Arabs, great as conquerors and organisers, did not, however, excel in science, and nearly all "Arabian" medical works are the products of men of non-Arab race, Persians, Moors, Jews, and others.

The golden age of Arabian learning culminated between A.D. 750 and 850, the century succeeding the establishment of the Abbasid Caliphate with its metropolis at Bagdad. In the thirteenth century Islamic civilisation suffered an injury from which it never recovered, through Tartar invasion, which destroyed for ever the Caliphate, the unity of the Arabian Empire, and the pre-eminence of Bagdad as a centre of learning. With this fall the hegemony

of the intellectual world passed to Europe mainly by means of material translated into Latin from Arabic, often through Hebrew. This material had itself been largely translated from Syriac, and the Syriac versions themselves were derived from Greek, so that Greek learning reached the West at third or fourth hand. But between the eighth and the thirteenth centuries science and learning, literature and culture remained, like civil organisation and military power, mainly with the Arabic-speaking peoples who stretched from India and Persia to the Atlantic seaboard. The learning of this period is described as "Arabian," and must be carefully distinguished from the true "Arab" material which comes only from Arabia.

It is certain medical aspects of this great Arabian civilisation with which Prof. Browne here deals. It is a subject with a vast literature that can scarcely be treated, even in outline, in a hundred and thirty pages. Apart from the actual changes which the medical system of Greece underwent in Arabian hands, and besides the actual contributions of Arabian authors themselves, an adequate history of Islamic medicine would need to treat of the psychological basis of those changes arising in part from the social and political circumstances of the time, in part from the racial characteristics of the Islamic peoples, and in part from the philosophy and general outlook prevalent among them.

The time is still distant when it will be possible to do this, and Prof. Browne, in this admirable little book, has essayed a smaller task. He concentrates on the work of a small number of the most important Arabian physicians, and notably on three Persians, known to the medieval Latins under the names of Rhazes, Haly Abbas, and Avicenna, whose works were the main carriers of the Arabian medical traditions to the West. Avicenna's enormous "Canon" is especially of importance as being—perhaps with the exception of the "Aphorisms" of Hippocrates—the most widely read work on medicine that has ever been written. More interesting perhaps to most readers will be Rhazes, whose memorable treatise on smallpox and measles was the first in which these diseases were differentiated. This work was translated by the late Dr. Greenhill in 1848, but, with that exception, Prof. Browne's is, so far as we know, the only modern book on Arabian medicine in the English language based on first-hand knowledge. It will be valued both on that account and as a very lucid and scientific exposition of a subject which very few besides Prof. Browne himself are qualified to treat.

Charles Singer.

Elementary Meteorology.

(1) *The Rainfall of the British Isles.* By M. de Carle S. Salter. Pp. xiii+295. (London: University of London Press, Ltd., 1921.) 8*s.* 6*d.* net.

(2) *Études Elémentaires de Météorologie Pratique.* By Albert Baldit. Pp. ix+347. (Paris: Gauthier-Villars et Cie, 1921.) 15 francs net.

(3) *Simple Lessons on the Weather for School Use and General Reading.* By E. Stenhouse. Pp. viii+135 +12 plates. (London: Methuen and Co., Ltd., 1921.) 4*s.*

(4) *Handbook of Meteorology: A Manual for Co-operative Observers and Students.* By J. W. Redway. Pp. v+294. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 24*s.* net.

(1) IN "The Rainfall of the British Isles" Mr. Salter gives a wealth of information that hitherto could be obtained only by searching through the volumes of "British Rainfall." The present work should therefore appeal to the large public which takes an interest in rainfall, and as some 5000 observers read their gauges daily it will be realised how large that public is. Almost every observer would benefit by a perusal of this work, where he will find a discussion of the problems which he himself is assisting to solve. He will find an account of the various types of gauge, and that some, still in use and still sold by instrument makers, are untrustworthy. He will find the exposure of gauges discussed, and he may improve that of his own. He will learn how the data he supplies are used, and find maps illustrating various types of rain, some almost wholly influenced by orographical features, some by the passage of depressions, and others due to thunderstorms.

The discussion of seasonal variation and annual fluctuation will be read with much interest at the present time. Numerous maps are a great feature of the book, and are most instructive; any one who thinks that his own gauge is worth keeping should study the map of the thunderstorm rain in London on June 16, 1917, and note that there was no rain at the Oval, more than $4\frac{1}{2}$ in. at Kensington, while one end of the Serpentine received less than 1 in. and the other more than 3 in.

The rain over the British Isles seems to fall into a watertight compartment; it is perhaps captious to complain that a book on our own rainfall does not discuss the rainfall of the Continent, but it would be of much interest to know how our rainfall links up with that on the other side of the Channel. Possibly the very excellence of the work of the British Rainfall Organization under Dr. Symons, Dr. Mill, and Mr. Salter himself, has made our own information so adequate that it

cannot be compared in full detail with that of neighbouring countries.

There are one or two slips; for example, "right hand rear section" on page 179 should be "right hand front section." The diagram in Fig. 2 is not sufficiently explained to be intelligible to those readers who are not already familiar with the theories of Prof. Bjerknes. The glossary at the end is not very full: we look in vain, for example, for orographical rain and for convection. The book fills a gap in meteorological literature, and the concluding chapter on the economic application of rainfall data is an indication of how widely it should be studied, not only by meteorologists, but also by those outside their ranks.

(2) "Etudes élémentaires de Météorologie pratique" describes the ideal arrangement of stations for a meteorological service, the instruments used, including captive balloons, pilot balloons, and aeroplanes, and the general procedure of such stations. Part 2 is devoted to problems of pressure and wind, and part 3 discusses forecasting. Squalls and thunderstorms come in for full treatment, and also the sudden clearings of the sky, "éclaircies"; the author's experience as chief of the meteorological service of the Armies of the Centre probably led him to study this phenomenon, so important for aviation and hitherto much neglected. The author advocates numerous observation posts, so that a line squall, for instance, may not pass unnoticed between the regular stations of the service. If such a system had been adopted in this country during the war much serious damage might have been avoided at aerodromes in the South of England. The work does not pretend to be a meteorological handbook, but it is valuable for those engaged in official meteorological work, and it discusses interesting points, some of which may still be rather controversial. The chief fault of the work, if fault it be, is that it is unnecessarily full, which would have made an index all the more useful.

(3) Mr. Stenhouse's little book is intended for school students and for the general reader. The subject, including something of dynamic meteorology, is shortly and clearly explained. But there are a number of inaccuracies which ought to be corrected if the work runs into further editions. The coldest time of day is not a little after midnight but a little before sunrise; strato-cumulus is scarcely a combination of stratus and cumulus, nor is cumulus the typical cloud of the middle layer. Alto-cumulus is not even mentioned; and the distinction between cloud sheets and clouds of convection is not brought out. There are some good photographs, but they have not been well selected; snow and frost scenes do not teach anything in particular, and a more typical selection of cloud forms should have been given; the clouds in Plate VI., though given as cumulus, are nothing of the kind; the top picture in Plate VII. has been inverted. The diagrams of sections across weather maps make a misleading use of the term pressure-gradient. In spite of faults, however, the book forms an attractive introduction to meteorology for beginners.

(4) Unfortunately this cannot be said for Mr. Redway's "Handbook of Meteorology," which contains many inaccurate statements. Hydrogen, on account of its lightness, is stated to be thrown off into space by the rapid movement of the earth; air currents "are deflected by the rotation of the earth on its axis easterly in tropical latitudes, and westward beyond the tropics"; the isothermal layer separates the stratosphere and the troposphere; the stratosphere is stated to be radioactive, indicating the presence of electrified dust particles, and the reason why cloud particles remain suspended is stated to be unknown, and electrification is suggested as a possible explanation; these are only a few of the surprising statements to be found in this work.

C. J. P. Cave.

Freshwater Ciliate Infusoria and Heliozoa.

(1) *Etudes sur les Infusoires d'Eau douce.* By Dr. E. Penard. Pp. 331. (Genève: Georg et Cie, 1922.)

(2) *The British Freshwater Rhizopoda and Heliozoa.* By J. Cash and G. H. Wailes. Assisted by J. Hopkinson. Vol. 5. *Heliozoa.* By G. H. Wailes. Pp. vi+72+11 plates. (London: for the Ray Society, 1921.)

(1) THERE is probably no large sheet of fresh water that has been so thoroughly investigated, so far as its fauna of protozoa is concerned, as the Lake of Geneva. Forel, Jean Roux, Penard, and others have shown its richness in variety of form, in the number of species, in cases of parasitism, and in adaptations to other special habits of life. They have set an example which we might well follow in regard to our English lakes, about which we still know so little.

Dr. Penard has already published massive volumes on the Rhizopoda, the Heliozoa, and the Acinetaria of the lake and neighbouring waters, and the present volume on the ciliate Infusoria, not restricted in this case to protozoa of the immediate locality, is no less imposing than the others.

Dr. Penard's work will doubtless meet with a great deal of severe criticism, because his histological methods are primitive and inefficient, his illustrations badly drawn and abominably reproduced, and the arrangement of the text is most inconvenient for the reader. But he disarms criticism, to some extent, as regards the first defect by his frank admission that all his observa-

tions have been made on the living organisms, and that only in certain cases has he used some *intra vitam* stains for special purposes. It is a grievous pity, however, that with such interesting material passing through his hands he has not been able to employ an artist to provide at least a few illustrations of the same delicacy and accuracy as those to be found in the works of Jean Roux. There is not a single one of the three hundred figures that can be said to be a good picture of a living infusorian. They are all crude and inaccurate diagrams.

But these serious defects must not be allowed to obscure the fact that there are recorded in this volume many very interesting and important observations on the natural history of these protozoa. The detailed account, for example, of the explosion of the large trichocysts of *Microthorax haliodiscus*, the description of the conjugation and gemmation of the new Heterotrich *Strombilidium gyrans*, the discovery of the formation of small copulation buds in Cothurnia, and many other records of the author's observations are really valuable contributions to knowledge, and suggest at any rate interesting lines of research for some one who can use more modern methods of technique.

Dr. Penard proposes to add to our lists the names of several new genera and many new species; but it seems very doubtful if these new genera and species can be established until a better and more trustworthy account of the nuclei and other details of structure can be provided. Any one who has had experience of investigations of these active minute organisms must be aware of the uncertainty of observations on the form and structure of the meganuclei that are made when the animals are still living. Such observations must be confirmed and extended by a study of properly fixed and stained preparations before they can be regarded as trustworthy. More particularly is this the case with the micronuclei, which are usually quite invisible during life and require the best technical methods for their complete elucidation; and we may note, in this connection, that the author does not mention either the sixteen micronuclei of *Bursaria truncatella* or the single but remarkably conspicuous micronucleus of *Spirochona gemmipara*.

In a group of animals such as the Ciliata, which possess so few trustworthy characters for systematic work and vary so much as regards these characters according to environmental conditions, the systematist should not be satisfied with his description of new species until every important character that can be seen by the ordinary methods of research has been seen and described. If microscopists pass from the description of one species of Ciliata to that of another before the nuclear structures of the first have been determined, as Dr. Penard has done, our literature, already overburdened with unnecessary specific names, will soon become most hopelessly perplexing and cumbersome.

Dr. Penard's work will be useful for reference, and perhaps suggestive of lines for further investigations by other methods of research, but it cannot be regarded as one that excites great confidence.

(2) The new volume on the freshwater Heliozoa of the British Isles published by the Ray Society gives a record of genera and the species that have been found by microscopists in this country who have been interested in the group, but it does not do justice either in text or plates to the important morphological features or to the beauty of form that these remarkably interesting protozoa possess.

It is very disappointing that in this monograph the general account of the structure and reproduction of the Heliozoa is so incomplete. For example, in the very slight treatment of the reproduction of Actinophrys and Actinosphærium there is no reference to the works of Schaudinn or R. Hertwig. It seems extraordinary also that those who are responsible for the publications of the Ray Society have no better methods to suggest to the young microscopist for the preservation of these delicate organisms than 5 per cent. carbolic acid, formalin, and methylated spirit, and that no methods at all are given for staining preserved specimens to bring out more clearly the structure of the nuclei and other minute details.

The purely systematic part of the work is more satisfactory, and the microscopist will find a short but clear description of all the species that have been recorded in this country with references to many of the more important papers in the literature of the subject. Of the eighteen text-figures only two seem to be original, the others being either reproductions of the coarse and lifeless illustrations in Penard's monograph or taken from other authors. Figures such as these, in which the detailed structure is not clearly or accurately shown, do not incite to careful and patient study, although they may assist to some extent in the identification of species. The illustrations in the plates also, with a few exceptions, are far below the standard we might reasonably expect in the publications of the Ray Society. They do not represent these beautiful little organisms as spherical in shape with radiating pseudopodia on the whole circumference, but rather as flat discs with the pseudopodia in one plane.

Another fault which seems to be unpardonable in a work of this kind is the failure to give any description or descriptive lettering of the figures to assist the reader. In such a figure as that on p. 44, for example, it is impossible to determine which of the several circles in the endoplasm of Pompholyxophrys is the nucleus and what the other things are supposed to represent. And again,

in the illustrations of *Actinophrys sol* on Plates 67 and 72 there is no explanation of the different forms of the body and its pseudopodia that are represented. A few lines on the opposite page giving the reason why six different drawings of this one species are shown on the first of these two plates would have added immensely to the value and interest of the account of the species.

S. J. H.

Our Bookshelf.

Organic Syntheses: An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Vol. 1. Pp. viii+84. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 8*s*. 6*d*. net.

In preparing materials for use in research work in organic chemistry, much difficulty is experienced and time wasted because adequate directions are not available. Moreover, the methods finally adopted are not often published, so that the work involved in discovering how to make the preparation successfully is lost, and may be repeated indefinitely in different laboratories. The present volume is the first annual instalment of a record of methods of proved merit, given in sufficient detail to ensure easy repetition; the methods given have been tested by being carried out from the instructions in a different laboratory from that in which these were drafted. The substances dealt with in the first volume are alkyl bromides, allyl alcohol, benzinesulphonic chloride, benzil, benzilic acid, benzoin, α-bromonaphthalene, *p*-bromophenol, diacetone alcohol, furfurol, mesityl oxide, methylene iodide, methylhexyl carbinol, oxalic acid, thiophenol, trimethylamine, and trimethylamine hydrochloride. In future volumes it is hoped to include preparations worked out in other countries and tested by repetition in one of the four American laboratories which are responsible for the organisation of the scheme.

The preparation of materials such as these in quantities of from 200 to 2000 grams offers a unique opportunity for determining their physical constants by exact methods, *e.g.* a determination of freezing points to 0·01° by means of a standardised thermometer recording the temperature of 100 grams or more of purified material, instead of to about 1° by the use of a milligram of material in a capillary tube attached to a thermometer of unknown errors. This useful development of the work may perhaps be looked for in the later volumes of the series.

T. M. L.

Exploitation du Pétrole par Puits et Galeries. By Paul de Chambrier. Pp. 106. (Paris: Librarie Dunod, 1921.)

In February 1921 a paper was read before the Institute of Petroleum Technologists on the working of petroleum by means of shafts and galleries, being an abstract from a pamphlet entitled "Exploitation du pétrole par puits et galeries," written by Prof. Paul de Chambrier. This pamphlet has recently come to hand, and it discusses at some length the methods employed more particularly at Péchelbronn, Alsace, in a bold attempt made to extract oil from certain horizons already exhausted by the drill.

The publication of the paper in this country created very considerable interest and even controversy at the time, and opinion was much divided as to the possibility of extending such methods to other fields. The pamphlet in its original form, however, makes most interesting reading, and there is no doubt that under certain specialised circumstances recourse may be had to this form of mining petroleum with decided probability of success. Such circumstances occur when (1) the producing bed has been drained so far as boring permits, (2) when there is an absence of gas under pressure, and (3) when the percentage of oil remaining in the bed is high enough to warrant the attempt being made. One may add a further condition, namely, that the bed does not lie at too great a depth from the surface.

The author contends that these methods allow the extraction of anything from two to five times the amount of oil obtainable by boring, and their ultimate employment, where possible, considerably enhances the economic value of the property. While these contentions may be quite justified commercially, it is open to doubt whether, from the scientific point of view, this practice will yield solutions to the fundamental questions of origin, migration and accumulation of petroleum, as indicated in the concluding paragraphs, but we recommend the careful perusal of the pamphlet before adverse criticism of this new departure be indulged in by either academic or technical expert.

H. B. Milner.

The Chemistry of the Garden: A Primer for Amateurs and Young Gardeners. By H. H. Cousins. Macmillan's Primers. Revised Edition. Pp. xxxi+147. (London: Macmillan and Co., Ltd., 1921.) 2*s*. net.

The new edition of Mr. Cousins's well-known little book will be welcomed by all who are interested in their gardens. In spite of the vast number of gardening books and the fact that it was first written twenty-three years ago, this book still remains one of the most useful guides that can be put into the hands of the amateur. Horticultural research does not move very quickly, and there has been less necessity for recasting than if the book had dealt with agriculture. Fuller investigation would no doubt cause modification in some of the recommendations made, but until it has been carried out the advice stands as the safest that can be given at present. Above all, its basis is sound. "I appeal," says the author, "to the gardeners of England to place themselves in line with the only true and sound method known to science, and the only safe and sure means to progress and discovery—experiment."

A Course of Practical Physiology for Agricultural Students. By J. Hammond and E. T. Halnan. Pp. 106. (Cambridge: At the University Press, 1920.) Price 4*s*. 6*d*. net.

This small book, which is not illustrated, contains exercises mainly in elementary histology for second-year students taking the course in agriculture at the University of Cambridge. Space is afforded for notes and drawings. The book will save time and labour for both student and teacher without disadvantage, as it does not pose as a text-book.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.*]

Atmospheric Refraction.

I perceive on further consideration that my suggestion (Nature, January 5, p. 8) of a spherical wave-front in place of a plane one to account for the discrepancy between the coefficient of terrestrial refraction as derived by Dr. Hunter from Mr. Mallock's proposition and the coefficient deduced from trigonometric levelling operations under ordinary conditions is inapplicable, for the reason that in practice we have to deal, not with a single point-source of light, but with an assemblage of point-sources the wave-front from which is sensibly plane.

There must, therefore, be some other explanation for the disagreement between the two values of the coefficient. I find on examining Dr. Hunter's figures (Nature, August 11, 1921, p. 745) that the almost exact two-to-one ratio between the values, which was suggestive of a simple geometrical explanation, is illusory owing to an unfortunate slip of Dr. Hunter in confusing sea miles with statute miles. The earth's radius in sea miles is not 3960, but 3437, and the resulting value of k from Mr. Mallock's proposition is not 0·133, as Dr. Hunter states, but 0·116. Using the Continental definition of k, this gives $k=0{\cdot}232$, which agrees with the value found by Jordan's formula (quoted in my former letter) for isothermal conditions at 0° C. As to the remaining discrepancy between 0·116 or 0·232 and the values of k (on the two definitions of it) which are usually found to hold in practice, it is clear both from Comdr. Baker's letter (Nature, January 5, p. 9) and from Jordan's formula that this is readily accounted for by temperature considerations. It is only under isothermal conditions, such as seldom or never occur in practice, that Mr. Mallock's result can be even approximately true; it was evidently incorrect to consider, as Mr. Mallock did in his reply to Dr. Hunter, that temperature effects could produce merely a difference in the result of 1 or 2 per cent. per 1000 ft. The mistake of assigning an insignificant part to temperature considerations is one which is very easily fallen into by any one who first considers the isothermal condition with its accompanying relation between density and pressure, because of the small effect which the existence of a temperature-gradient has on the rate of decrement of pressure as distinguished from density.

The great interest of Mr. Mallock's demonstration lies in its deriving the refractional radius under certain conditions in a very simple and elegant manner from the velocities of light in air and *in vacuo* and the height of the homogeneous atmosphere. What has led to some confusion is the omission from the enunciation of the proposition of the qualification that it holds true only for isothermal conditions and for air at 0° C.

Putting p for pressure, ρ for density, and h for height, we may take the refractional radius as depending only on dp/dh, as Mr. Mallock does, so long as we keep to isothermal conditions. But once we depart from these conditions, as is inevitably the case in practice, we must take it as depending on $d\rho/dh$, which no longer corresponds to dp/dh. We can, however, extend the simplicity of Mr. Mallock's reasoning to the condition of a linear temperature-gradient provided we replace the height of the homogeneous atmosphere, $-pdh/dp$ (or "pressure height," as Prof. Everett preferred to call it in his "C.G.S. System of Units"), by the "density height," $-\rho dh/d\rho$, which latter may be much greater than the "pressure height" under ordinary conditions.

Comdr. Baker lays great stress on the fact that the path of the refracted ray cannot be a circular arc unless the temperature-gradient is linear. This stress is justifiable, especially from the seaman's point of view of the problem; for the temperature-gradient in the air immediately over the sea is frequently far from linear, and in navigation horizontal sights must always be taken fairly close to the surface of the sea; moreover, it will seldom happen that the most favourable time of day can be chosen for observations at sea.

The moral is that in navigation too much reliance should never be placed on the results of observations made on a single bearing whenever the accuracy of the tabular value of the dip has to be assumed. But the land-surveyor is much less limited by conditions than the seaman; he can generally keep his lines well above the ground by observing between points of considerable elevation, he can choose that time for his observations when refraction is least likely to be abnormal, and he can usually get an adequate check on his results for the elevation of a point by observing it from a number of others at different distances and comparing the results. As a matter of experience, it is found by surveyors in many countries that during the afternoon hours, when refraction is steadiest, the assumption that the temperature-gradient is linear and the path of a nearly horizontal ray consequently a circular arc is tolerably near to the truth, at any rate for lines which do not run very close to the ground for any considerable part of their length. This follows from the close concordance between the trigonometric levels obtainable for the same point from stations at very different distances, when the observations have been taken under proper conditions and worked out by the usual formulæ.

John Ball.

Survey of Egypt, Cairo, February 11.

Diffraction by Molecular Clusters and the Quantum Structure of Light.

The investigations on the molecular scattering of light now in progress under the writer's direction (regarding which previous communications have been published in Nature) have brought to light some very remarkable cases in which the observed facts are in sharp contradiction with the theories of light-scattering based upon Maxwell's electromagnetic equations. According to the Einstein-Smoluchowski formula for the scattering power of a fluid, viz.

$$\frac{\pi^2}{18}\frac{\mathrm{RT}\beta}{\mathrm{N}\lambda^4}(\mu^2-1)^2(\mu^2+2)^2,$$

the intensity of the diffracted beam should be proportional to the compressibility β of the fluid and should thus be very large near the critical temperature as the compressibility is there great. Experiments by Keesom and Kammerlingh Onnes have confirmed this result in the case of ethylene vapour over a range of a few degrees above the critical temperature. The scattering powers of liquid carbon di-oxide and vapour for a considerable range of temperatures below the critical point have been determined in the writer's laboratory by Mr. K. R. Ramanathan, who has discovered that the formula is approximately valid only for a range of a few degrees below the critical temperature, and then

falls off much more rapidly than according to the formula. These observations are significant in view of the observation by the present Lord Rayleigh that the scattering power of saturated carbon di-oxide vapour at 21° C. is only 102 times that of the gas at atmospheric pressure, whereas according to the Einstein-Smoluchowski formula, it should have been 855 times as great.

The failure of the formula indicated above is especially surprising in view of its successes in other directions, namely, in the case of gases obeying Boyle's law, in the case of liquids under ordinary conditions, and, with certain restrictions, even in the case of solids. In attempting to find an explanation of the failure, at first sight one naturally seeks to find some flaw in Einstein's theory, or in the application of it, but the very successes of the formula in other cases would tend to discourage such an attempt. The formula was deduced by Einstein by applying Boltzmann's principle of entropy-probability in order to find the magnitude of the fluctuations of density of the fluid arising from thermal agitation and deducing the light-scattering due to these fluctuations by application of Maxwell's electromagnetic equations. It is clear that density fluctuations due to thermal agitation must occur; that their magnitude is proportional to the square root of the compressibility of the medium as contemplated in the theory may be confirmed independently by identifying the thermal energy of the molecules with the energy of sound-waves of all possible wave-lengths in an enclosed volume of the fluid and equating the energies. Further, the idea that the non-uniformity of the density of the medium is the factor determining light-scattering, at least according to the wave-theory, is confirmed by the very complete analysis of the problem given by the late Lord Rayleigh in one of his final papers (*Phil. Mag.*, Dec. 1918, p. 449). How, then, are we to escape the difficulty?

A very luminous suggestion made by Jeans in his "Dynamical Theory of Gases" (page 203) is here of great help. Jeans distinguishes between two kinds of clustering in fluid media, *mass-clustering* and *molecular-clustering*, and points out that they tend to become identical at the critical temperature. Einstein's theory is based on the idea that the fluctuations of density and the resulting scattering of light are both due to *mass-clustering*. If, however, we assume that it is *molecular-clustering* that is of importance and results in an increased scattering of light, it is easy to see that in the case of molecules such as carbon di-oxide, which are ordinarily non-associated, the clustering of molecules would only be appreciable near the critical temperature, and that at lower temperatures the clusters would rapidly break up and resolve themselves into single molecules. A double molecule would scatter four times as strongly as a single molecule, a triple molecule nine times as strongly, and so on, and if we assume that the energy-effects of separate molecules or groups are additive, and calculate the number of associated molecules from thermodynamic principles, it is easy to give the theory quantitative expression and explain the increased scattering near the critical point, and the rapid fall at lower temperatures.

But the fundamental difficulty remains, why the *mass-clustering* considered by Einstein does not, as it should, according to the classical wave-theory of light, give rise to an increased scattering of light?

To the present writer, at any rate, it appears that this contradiction of the electromagnetic theory by experience may have to be classed with its other known failures in the theory of photo-electricity and other modern fields of inquiry. We may, in fact, have to adopt the quantum theory of the structure of light as propagated in space (and not only when it is absorbed or emitted) in order to explain the facts of molecular diffraction. Fuller experimental data which are now being obtained in the writer's laboratory may pave the way towards the clearing up of this fundamental question.

C. V. RAMAN.

210 Bowbazar Street, Calcutta, March 2, 1922.

The Radiant Spectrum.

PROF. RAMAN in his reply of February 9 to my criticism of his first letter of September 1, does not refer to the fundamental difference of opinion between us. For it was the statement "the phenomenon is due to diffraction by the corneal corpuscles," to which I took exception, because I could not find in his letter, or in Brewster's paper, any evidence on which such a conclusion could be based.

With regard to the corneal corpuscles, Schafer writes in his "Essentials of Histology" (p. 363, edition 6), "Between the laminæ (of the cornea) lie flattened connective tissue corpuscles, which are branched and united by their processes into a continuous network; there is, of course, a corresponding network of cell spaces." Since, then, the corneal corpuscles lie within the substance of the cornea, their optical effect will depend on their opacity to light, or on the difference between their refractive index and that of their surroundings. Now if there was opacity, or a difference in refractive index, they should be visible under the microscope. But such is apparently not the case. Staining with hæmatoxylem or some other suitable reagent, is necessary in order that they may be visible, and therefore their opacity, or difference in R.I., must be slight. We conclude, therefore, that they will cause but slight diffraction in a ray of light passing through the cornea. In shape the cells themselves are *highly* irregular, and they average in man 20-30 μ in diameter. Their nuclei in man are roughly oval in shape, about 16 μ in diameter. In order that these structures should produce the type of diffraction pattern described by Prof. Raman, there should be two sets of them, nearly circular in outline, with diameters of 13 μ and 7 μ respectively. But a further point arises: Prof. Raman describes slight relative movements on the part of the diffraction pattern, which he compares with those which occur when a film of milk on glass is held in front of the eye. This movement, he states, ceases if the eyelids and eyeball be kept motionless for a short time. Could the corneal corpuscles undergo this movement lying as they do in lacunæ in the substance of the cornea? And even if they could, why should their motion cease when the lids and eyes are kept still?

Not only has no evidence been advanced by Prof. Raman in support of his statement that the corneal corpuscles are responsible for the diffraction phenomena, but also the shape, size, situation, and optical properties of these structures would appear to be antagonistic to the view.

With regard to the scattering of light by a prism, the following experiment will be found to demonstrate the effect. On the bed of a spectrometer are placed, base to apex, two glass prisms of equal dispersion, with optically good and clean surfaces (see Fig. 1).

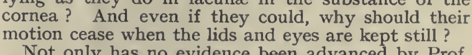

FIG. 1.—L.S., Arc or Pointolite. C., Condenser. S., Slit. T.¹, Lens of Collimator. P. & P.¹, Prisms. T.², Lens of Telescope. M., Metal Strip. E., Eye of Observer.

The telescope eye-piece having been removed, a

Q 2

narrow vertical strip of black sheet-metal or cardboard is fixed across the mouth of the telescope with plasticine, and the telescope is adjusted until the bright image of the slit is completely obstructed. On looking past the strip towards the prisms the observer will see parts of the latter brilliantly lit. By slightly shifting each prism in turn and watching for movement in the bright specks, those due to each prism are readily identified. H. Hartridge.

King's College, Cambridge.

Land Snails of the Madeira Islands.

In 1892 (*Journal of Conchology*, vol. vii. No. 1) the Rev. R. Boog Watson published a very interesting discussion of the Madeira snails, in which he raised many questions concerning their origin and history, which he did not attempt to answer. To-day, we are still groping for light, but I believe we may reach a number of conclusions which are not likely to prove erroneous.

(1.) It is not true that the numerous endemic snails of the islands have come "without trace of descent." They are quite clearly of Palæarctic origin, and their ancestors may be looked for in the rocks of Europe. Among the European Tertiary fossils, *Plebecula ramondi* Brong., from the Miocene of Germany, resembles the Madeira and Porto Santo Pleistocene fossil *P. bowditchiana*; *Pseudocampylaea insignis* Klein, from the Miocene of Würtemberg, resembles the great *P. lowei* of Porto Santo, but is not so large; two species of Craspedopoma, apparently allied to Madeira forms, are found in the Eocene of France. These fossils may be seen in the British Museum. In the absence of anatomical evidence, the relationships of these fossils must remain somewhat uncertain, but it is at least probable that their apparent affinity with the Madeira snails is not wholly deceptive.

(2.) Considering the diversity and strong peculiarities of most of the Madeira species, it is unlikely that their ancestors arrived later than the beginning of the Tertiary, and it is not improbable that at least part of the immigration dates from the Upper Cretaceous. This postulates a greater age for the islands than our present geological information can confirm. According to this view, the European fossils are presumably not the actual ancestors of the Madeira fauna, but derivatives from the same general stock.

(3.) A comparison between the snails of Madeira and the adjacent island of Porto Santo, which is easily visible from the coast of the larger island, shows that we have two very distinct faunæ, with very few species in common. More than this, various genera or subgenera are restricted to one of these islands, or specially characteristic of one. It is, I think, quite certain that during the whole long history of the snail fauna, Madeira and Porto Santo were never united. On the other hand, everything indicates that the three Desertas were during Tertiary time joined together and continuous, or nearly continuous, with Madeira. The following facts are illustrative:

Pseudocampylæa. Two species, Porto Santo only.

Cryptaxis. Three species, Madeira and Desertas (Leptaxis differs anatomically, as I shall show elsewhere).

Katostoma. Several forms, Porto Santo and adjacent islets.

Lampadia. One species, Porto Santo. (The Madeiran *membranacea* does not belong here.)

Idiomela. One species, Porto Santo.

Hispidella. One species, Madeira.

Lemniscia. One species, Porto Santo. (I am satisfied that the Madeira *calva* and *galeata* are not related.)

Actinella. Five species, Madeira and Desertas.

Hystricella. Seven species, Porto Santo and adjacent islets.

Geomitra. Seven species, Madeira and Desertas.

This list could be extended, but it is, I think, sufficient to indicate, not only that Madeira and Porto Santo were not united, but that they were never united with the mainland. The diversity of the genera and subgenera on the two islands might be expected as the result of accidental colonisation at very rare intervals, but could scarcely result from the breaking up of an originally homogeneous fauna. If we employ the aggregate genera Leptaxis and Geomitra (properly Ochthephila Beck, which is not preoccupied) without subdivision, the actual facts are obscured.

(4.) Nevertheless, we have to account for the occurrence of a certain number of identical species in the two islands, and the fact that some of the groups, such as Discula, are well represented on both islands, with closely allied species. The identical species were not introduced by man, as they occur fossil in the Pleistocene of Caniçal. As a general rule, when a group has representatives on both islands, it appears to be primarily or primitively a Porto Santo group. An apparent exception is Callina, with four Madeira species and one (*rotula*) in Porto Santo. The species *rotula* is very peculiar, and probably should not be associated with the others. How these various snails or their ancestors crossed the 23 miles from one island to the other is unknown. Some may have been carried by birds, possibly some may have come on floating pumice or other floating objects.[1] The reason for the apparent tendency of Porto Santo types to reach Madeira, rather than the reverse, may be found in the fact that the arid eastern end of Madeira is well suited to Porto Santo species, while Porto Santo is unsuited to the species from the moister uplands or coasts of the greater part of Madeira.

(5.) The occurrence of well-defined species and subspecies on the islets around Porto Santo—some of them no larger than a large building—proves that no important oscillations of level have taken place in recent geological time. Very moderate alterations of level would submerge the islets, or unite them with the main island. The existence of these distinct forms on islets close to the main island also proves that the means of crossing the sea, whatever they are, operate at extremely infrequent intervals.

(6.) With regard to the species of the Madeiras which are actually identical with those of Europe, it must be said that the presumption is in nearly every case that they were introduced by man. It is possible, however, that some of the smaller ones were brought by "natural" means in geologically recent times, and highly probable that Balea was so brought to Porto Santo, on the feet of birds. Records of the occurrence of European species in the Pleistocene deposits of Madeira and Porto Santo all break down on critical examination.

That the islands are really "oceanic" is indicated by the total absence of indigenous mammals (except bats) and amphibians, and the general character of the invertebrate fauna and of the flora. The multitude of snails has seemed to suggest a former land connection, but I now believe that the snails themselves negative this view. T. D. A. Cockerell.

University of Colorado, Boulder, March 2.

[1] Experiments should be made to determine whether it is even possible for snails protected by epiphragm or operculum, to pass alive through the alimentary canal of birds. Compare Wallis Kew, "The Dispersal of Shells," p. 45.

Optical Rotatory Dispersion.[1]

By Prof. T. M. Lowry, F.R.S., and Dr. P. C. Austin.

1.—*Introduction.*

The discovery of optical rotatory dispersion may be said to have preceded rather than followed the discovery of optical rotatory power, since it was the unequal rotation of the plane of polarisation of lights of different wave-lengths which gave rise to the sequence of beautiful colours which Arago described in 1811 as being produced by the interposition of quartz plates between a polariser and analyser set to extinction. These colours were shown by Biot in 1812 to be due to a rotation of the plane of polarisation which increased with the thickness of the quartz plate and with change of colour from red to violet. When, therefore, a beam of polarised light had passed through a quartz plate it was impossible any longer to extinguish all the colours simultaneously with any one setting of the analyser.

Two features of Biot's work deserve special attention. In the first place, all his measurements of optical rotatory power included observations of rotatory dispersion; the custom of observing the rotatory power of a substance for light of only one wave-length and thus recording a single point on a curve of unknown form is of comparatively recent origin, and marks a distinct retrogression from the more thorough methods of the earlier workers. The second characteristic was the exact quantitative character of the work. Although he had no source of monochromatic light except a ruby glass which gave a red light of average wave-length about 6530, Biot made a quantitative study of the influence of wave-length and of other physical conditions on rotatory power, expressing his results, whenever this was possible, by means of mathematical equations and diagrams.

Two of Biot's diagrams retain their interest even at the present time. The first shows, by means of a series of straight lines, the influence of dilution with water on the rotatory power of tartaric acid. This diagram enabled Biot to predict that dextro-tartaric acid when in the anhydrous glassy form would actually become lævorotatory at the red end of the spectrum at all temperatures below 23° C., a bold prediction that was verified experimentally ten years later.

The second of these diagrams was used by Biot to illustrate his discovery that the rotation of the plane of polarisation of light in quartz was inversely proportional to the square of the wave-lengths, using the figures determined by Newton for corresponding regions of the spectrum. In this diagram the thickness of quartz required to produce a given rotation was plotted against the square of the wave-length, and the result was a series of straight lines. Biot recognised that some of the readings differed from the calculated rotations by 2 or 3 per cent., but he was not in a position to decide whether these deviations were due to experimental errors or to some inaccuracy in his formula. Our own measurements have shown that Biot's diagram represents almost exactly the rotatory dispersion in quartz if the lines are drawn through a point a little to the right of the origin, and there can be little doubt that if more accurate methods of measurements had been available Biot's line of thought and method of representation would have led him almost inevitably to the simple formula for rotatory dispersion which has come into general use in recent years after the lapse of nearly a century.

2.—*Simple Rotatory Dispersion.*

As the accuracy of polarimetric work increased, the deviations from Biot's law of inverse squares became too important to be overlooked. The result was unfortunate, since those who destroyed the original formula had not got the skill to replace it by one that was more exact. For half a century, therefore, work on rotatory dispersion was limited to the occasional plotting of a curve of unknown form to represent the relationship between rotatory power and wave-length. As a natural result interest in the study of rotatory dispersion diminished, and (following the discovery of the Bunsen burner in 1866) the D line of the sodium flame acquired almost a monopoly as a source of light for the investigation of optical rotatory power.

During this period corrected formulæ were put forward by Boltzmann, who wrote $\alpha = A/\lambda^2 + B/\lambda^4$, and by Stefan, who wrote $\alpha = A + B/\lambda^2$; but these proved to be of little value, since they could not readily be made to fit the curves, and, being obviously empirical in character, could be used only as a means of interpolation between the experimental values.

This period of retrogression came to an end with Drude's application to optics of the electronic theory at the close of the nineteenth century. His theoretical investigations led to the enunciation of a somewhat elaborate formula for optical rotatory dispersion which (when approximate results only were required) could be used in the simplified form shown in the equation,

$$\alpha = \Sigma \frac{k_n}{\lambda^2 - \lambda_n^2},$$

where the dispersion-constants $\lambda_1^2, \lambda_2^2 \ldots \lambda_n^2$, could be deduced from the refractive power of the medium, while k_n represented a series of arbitrary constants depending on the rotatory power of the medium. A similar formula, which actually included the refractive index, was put forward to express the influence of wave-length on magnetic rotatory power. Drude tested his formula for optical rotatory dispersion in the case of quartz, whilst that for magnetic rotatory dispersion was tested in the case of carbon disulphide and of creosote; but for some years both formulæ remained almost barren so far as practical applications to measurements of rotatory dispersion were concerned. In particular, it may be noted (i) that a complete knowledge of the curve of refractive dispersion was required before either formula could be applied to measurements of rotatory dispersion, and (ii) that even the approximate formula for optical rotatory dispersion contained an indefinite number of arbitrary

[1] Abridged from the Bakerian Lecture delivered before the Royal Society on June 2, 1921.

constants. Drude himself did not apply his formula to a single member of the vast array of optically active liquids and solutions, which have been prepared and studied more especially from the time of Pasteur onwards, and he can, perhaps, scarcely be blamed for this omission, in view of the fact that the rotatory power of the great majority of these media had been determined for one wave-length only. It was therefore not until the problem of rotatory dispersion had been taken up afresh and new series of exact measurements had been accumulated that the unique merit of Drude's formula was established.

The results of these new tests were most striking. Fifty series of measurements of magnetic and optical rotatory dispersion were made and classified into groups with similar rotatory dispersion, in order to minimise individual errors of observation. It was then found (Lowry and Dickson, Trans. Chem. Soc., vol. 103, p. 1067, 1913) that the whole of these readings could be expressed within the limits of experimental error by using a single term of Drude's equation, involving only two arbitrary constants—namely, a "rotation-constant," k, and a "dispersion-constant," λ_0^2, as set out in the equation $\alpha = k/(\lambda^2 - \lambda_0^2)$.

The substances examined at this stage were nearly all compounds of simple structure—*e.g.* secondary alcohols of the aliphatic series; but the two methyl glucosides, each containing five asymmetric carbon atoms, were proved to obey the same simple law (Lowry and Abram, Trans. Faraday Soc., vol. 10, p. 112, 1914). A somewhat dramatic vindication of Drude's formula, in the case of compounds of much greater complexity, has, however, been provided by the more recent work of Prof. Rupe, of Basel, who published in 1915 (Ann. der Chem., vol. 409, p. 327, 1915) a series of measurements of the rotatory power for four different wave-lengths of some forty compounds of the terpene series. In order to determine the mathematical form of the dispersion-curves he plotted α against λ, log α against λ, log α against $1/\lambda$, α against $1/\lambda$, α against $1/\lambda^2$ (to test Biot's equation and Stefan's equation), and $\alpha\lambda^2$ against $1/\lambda^2$ (to test Boltzmann's equation); but in no case was there any indication of a linear relationship. The results obtained by plotting $1/\alpha$ against λ^2, in order to test the validity of the one-term Drude equation (Lowry and Abram, Trans. Chem. Soc., vol. 115, p. 300, 1919), are, however, most remarkable, since thirty-seven of the forty substances studied by Rupe give straight lines, and only three show any marked curvature. It is, moreover, noteworthy that two of these exceptional compounds agree in containing the group, $C:C(C_6H_5)_2$, although it is not clear why this group should be associated with the occurrence of abnormal optical properties.

Further work by Pickard and others has confirmed the fact that the rotatory dispersion of a vast range of organic compounds can be represented by the simple formula $\alpha = k/(\lambda^2 - \lambda_0^2)$, and that a satisfactory classification of optically active compounds can be made by distinguishing between "simple rotatory dispersion," where this law holds good within the limits of experimental error, and "complex rotatory dispersion," where marked deviations from the law are found.

3.—*Complex and Anomalous Rotatory Dispersion.*

Amongst the substances which do not obey the simple law of rotatory dispersion, tartaric acid and its derivatives have been conspicuous ever since Biot in 1837 directed attention to the peculiar behaviour of the acid in aqueous and in alcoholic solutions. The principal anomaly noted by Biot was the fact that the rotation, instead of increasing continuously with decreasing wave-length, rose to a maximum in the green, and then diminished again in the blue, indigo, and violet to values almost as low as those observed in the red region of the spectrum; but the extreme sensitiveness of the rotatory power of the acid to changes of temperature and concentration, as well as to the influence of solvents and of chemical agents, was in Biot's opinion at least as important an anomaly as the maximum in the curve of rotatory dispersion.

When, however, the quantitative basis for the study of rotatory dispersion had been destroyed, attention was no longer directed to the deviations from the law of inverse squares (which were then recognised as being universal), but to the qualitative peculiarities of the curves, which alone were regarded as justifying the use of the term "anomalous dispersion." The principal anomaly thus selected for special attention was the occurrence of a maximum; but a reversal of sign or a decrease of optical rotation with diminishing wave-length were sometimes included as anomalies of similar importance. The undue emphasis thus laid upon the qualitative anomalies has had some curious results; in particular, Winther not only adopted the view that the maximum is the sole criterion of anomalous rotatory dispersion, but actually insisted that this maximum must lie within the visible region of the spectrum. He therefore speaks of a dispersion-curve which "becomes normal in that the maximum passes into the ultra-violet," whilst a curve which cuts right across the axis is described as "normal with a maximum in the infra-red." A definition of anomalous dispersion which thus depends on the physiological properties of the eye, instead of on the physical properties of the medium, can scarcely be regarded as worthy of serious consideration, but it provides a suitable anticlimax to direct attention to the value of the more precise methods of treatment which prevailed when rotatory dispersion was first studied almost a century before.

A complete solution of the problem of anomalous rotatory dispersion has been found by returning to the mathematical methods of Biot and applying similar processes of analysis to curves plotted with the greater accuracy which modern physical apparatus has rendered possible. A series of dispersion-curves (Fig. 1) for aqueous solutions of tartaric acid of different concentrations will illustrate the typical forms of the curves that are encountered in studying the substances of this group.

These curves show clearly three principal anomalies—*inflexion*, *maximum*, and *reversal of sign*—appearing at various points on the experimental curves as the concentration of the solutions is altered.

Similar curves, but covering a wider range, are obtained when the esters of tartaric acid—*e.g.* methyl tartrate and ethyl tartrate (Fig. 2)—are examined as

homogeneous liquids at different temperatures or in a series of different solvents (Lowry and Dickson, Trans. Chem. Soc., vol. 107, p. 1183, 1915; Lowry and Abram, *ibid.*, p. 1193).

Careful mathematical analysis has shown that all

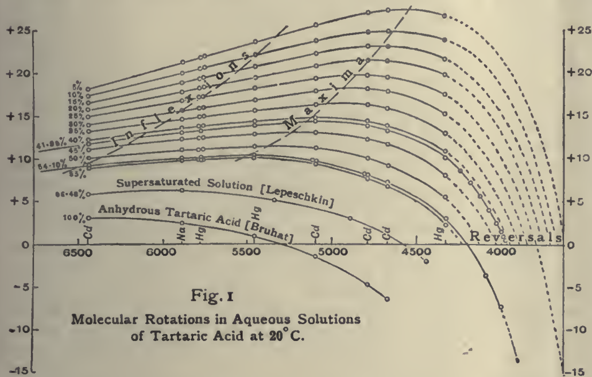

Fig. 1

Molecular Rotations in Aqueous Solutions of Tartaric Acid at 20° C.

these curves can be expressed by two terms of Drude's equation, of opposite sign and with unequal dispersion-constants—*e.g.*

$$\alpha = \frac{k_1}{\lambda^2 - \lambda_1^2} - \frac{k_2}{\lambda^2 - \lambda_2^2}.$$

The agreement is particularly good in the case of the esters. In the case of aqueous solutions of tartaric acid the ionisation of the acid appears to introduce an additional factor of complexity giving rise to small but systematic deviations from the values calculated by means of a two-term formula.

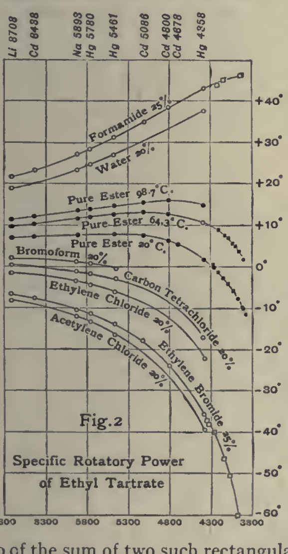

Fig. 2

Specific Rotatory Power of Ethyl Tartrate

In cases of "simple" rotatory dispersion Drude's formula postulates a linear relation between $1/\alpha$ and λ^2, but gives a rectangular hyperbola when α is plotted against λ^2. The corresponding dispersion-curves for methyl and ethyl tartrates are made up of the sum of two such rectangular hyperbolas, lying on opposite sides of a common horizontal asymptote, but working up to two different vertical asymptotes. These simple hyperbolas lie beyond the curves for solutions in formamide and in acetylene chloride, which are the highest and lowest of the series shown in Fig. 2, but every curve in this figure can be represented as a weighted mean of two such hyperbolas.

It should be noted that in this series of compounds the negative term always has a higher dispersion-constant than the positive term, so that the asymptote of the negative hyperbola is nearer to the visible region of the spectrum than that of the positive hyperbola. All the positive rotations are therefore drawn over towards the negative side as the wave-length diminishes, as in the top curve of Fig. 2, which shows a reversal of curvature on the extreme right. The curves in the upper part of Fig. 2 must therefore show, not merely one, but *all* of the features which are usually regarded as characteristic of anomalous rotatory dispersion—namely, (i) an inflexion, (ii) a maximum, (iii) a diminution of rotatory power with decreasing wave-length, (iv) a reversal of sign.

On the other hand, the curves at the bottom of Fig. 2 are negative throughout, since the positive term is always smaller than the negative term of the equation. There is therefore no inflexion, maximum, or reversal of sign. The curves obtained by plotting α against λ^2 are, however, not rectangular hyperbolas, but the weighted means of two hyperbolas, and require two terms of the Drude formula to represent them. Although, therefore, these curves are not anomalous, they are not "simple," and must be classed with the anomalous curves as "complex."

It should be noted that a small alteration in the numerical values of the constants of the equation for a complex curve may suffice to introduce the whole range of anomalies, or alternatively to remove them, whereas, to render a complex curve simple, one of the two terms in the complex equation must be made to disappear altogether. The difference between simple and complex dispersion is therefore probably of more significance than that between normal and anomalous dispersion, in spite of the more picturesque character of the latter contrast.

4.—*The Origin of Anomalous Rotatory Dispersion.*

It has been shown above that the curves of rotatory dispersion of organic compounds may be of three types—(i) simple, as in the case of the vast majority of the alcohols, acids, sugars, terpenes, etc., to which reference has already been made; (ii) complex, but without anomalies, as in the case of the tartaric esters when dissolved in solvents such as acetylene tetrachloride; (iii) anomalous, as in the case of tartaric acid and its esters. What, then, is the origin of the complexities seen in classes (ii) and (iii)? Mathematically they depend on the same fundamental factor—namely, the introduction into the equation of rotatory dispersion of a second term of opposite sign, which is absent in class (i). From the chemical point of view it is difficult to avoid the conclusion that the complexities expressed by the two-term formula are due to the presence in these liquids of two kinds of optically active molecules, differing in sign and in dispersive power, but each characterised by a simple rotatory dispersion corresponding with one term of the equation.

This suggestion is far from new. Biot himself, as long ago as 1836, produced an artificial anomaly when he attempted to compensate the optical rotatory power of lævorotatory turpentine by means of a column of dextrorotatory oil of lemon. Similar results were obtained with artificial mixtures of turpentine and camphor; and so long ago as 1858 Arndtsen, after establishing by his own measurements the unequal dispersive power of optically active compounds, made the following suggestions :—

"If one should imagine two active substances which do not act chemically upon one another, of which one turns the plane of polarisation to the right, the other to the left, and, in addition, that the rotation of the first increases (with the refrangibility of the light) more rapidly than that of the other, it is clear that, on mixing these substances in certain proportions, one would have combinations which would show optical phenomena precisely similar to those of tartaric acid, as M. Biot has already proved by his researches on different mixtures of turpentine and natural camphor. One could then regard tartaric acid as a mixture of two substances differing only in their optical properties, of which one would have a negative, and the other a positive, rotatory power, and of which the rotations would vary in different proportions with the refrangibility of the light."

This suggestion, made more than sixty years ago, can now be supported by two additional lines of argument: (i) the mathematical evidence that the rotatory dispersion of these substances is in fact the sum of two simple rotations—*e.g.* as expressed graphically by the fact that the complex curves obtained by plotting α against λ^2 are merely the weighted mean of two rectangular hyperbolas; (ii) the chemical evidence that mixtures of isomers do in fact exist, which fulfil the conditions laid down by Arndtsen. Of these optically active "dynamic isomerides" nitrocamphor was one of the earliest examples to be studied, and it is still one of the best illustrations that can be given of this group of phenomena.

The existence of two forms of nitrocamphor was proved by the discovery of mutarotation—*i.e.* change of rotatory power with time in freshly prepared solutions of the compound; but a mere trace of a catalyst, such as piperidine at a concentration of M/10,000, is sufficient to speed up the isomeric change to such an extent that mutarotation can no longer be detected. In tartaric acid and its esters similar conditions of rapid interconversion appear to prevail, since careful observations have failed to detect any lag of rotatory power after dissolution, dilution, distillation, or fusion. As in the case of nitrocamphor, however, it is possible to recognise, in addition to the usual mixtures, a certain number of derivatives of a fixed or homogeneous character, and these are characterised by opposite rotatory powers and unequal simple dispersions, precisely as we have postulated for the two modifications of the parent acid. Thus (i) tartar emetic differs from the other tartrates not only in showing a much higher rotatory power, but also in giving a dispersion-curve of the "simple" type which is characteristic of the vast majority of optically active organic compounds; (ii) on adding an excess of alkali to tartar emetic a lævorotatory derivative is produced, but this also exhibits simple rotatory dispersion; (iii) boric acid also possesses the power of fixing tartaric acid in a dextrorotatory form with simple rotatory dispersion.

In view of these observations it is difficult to resist the conclusion that tartaric acid, like nitrocamphor, can exist in two forms and yield two types of derivatives, and that the presence of these two types is responsible for the complex rotatory dispersion of the acid and of so many of its derivatives. The molecular structure of these two types is a fascinating problem which still awaits investigation.

Obituary.

Dr. G. B. Mathews, F.R.S.

Briefly recorded in Nature a fortnight ago, the death of Dr. George Ballard Mathews occurred in a Liverpool nursing home on March 19.

Born in London (February 23, 1861), of a Herefordshire family, Mathews' versatile intellect showed itself during his schoolboy days at Ludlow Grammar School, where the then head master instructed his boys in Hebrew and Sanscrit as well as in Greek and Latin. After a year at University College, London, where he studied geometry under Henrici, and of which body he later became a fellow, he entered St. John's College, Cambridge, which offered him the senior scholarship of his year either in mathematics or classics. Carrying out his intention of reading for the Mathematical Tripos he became a private pupil of Mr. W. H. Besant of St. John's. The keen competition for leading places in the Tripos of this period had brought fame to Mr. E. J. Routh as a coach and all the abler candidates went to Routh as a matter of course, for Routh had a long series of senior wranglers to his credit. However, Mathews' name was read out first in the list of 1883, this being the only break in a succession of about thirty consecutive seniors trained by Routh.

In 1884 Mathews was appointed to the chair of mathematics in the then newly-constituted University College of North Wales at Bangor, his election to a fellowship at St. John's taking place the same year. His colleagues at Bangor were all of the same generation as himself and included such men as Professors Andrew Gray, James Dobbie, and the late Henry Jones under the leadership of Principal Harry Reichel (the last three named have all since been knighted). The Bangor chair was resigned in 1896, and shortly followed by Mathews' election into the Royal Society and by his return to Cambridge as University Lecturer in Mathematics. During this period he was mathematical secretary of the Cambridge Philosophical Society for a time and also served on the Council of the Royal Society and on that of the London Mathematical Society. Resigning the Cambridge appointment in 1906 he returned to Bangor and, since 1911, held a special lectureship in the North Wales University College. The honorary degree of LL.D. was conferred by Glasgow University in 1915, and he again acted as professor of mathematics in Bangor during the two College sessions 1917–19. Dr. Mathews himself attributed the distressing series of illnesses which clouded

the last three years of his life, and ended it, to the enforced system of rationing during the latter part of the war.

While thoroughly familiar with all branches of pure mathematics, Mathews' main interests were in the theory of numbers and projective geometry. The theory of numbers which, in its widest sense, is the theory of discrete as opposed to continuous magnitude, has passed through four well-defined stages of development. First there came the Diophantine analysis proper, of which the greatest exponents, after Diophantos among the ancient Greeks, were Fermat and Euler. In this the general problem is to determine all the solutions in rational numbers of a system of m $(\angle n)$ algebraic equations.

$$R_i(x_1, x_2, \ldots x_n)=0, \quad i=1, 2, \ldots m.$$

Next came the discovery of the law of quadratic reciprocity which rendered possible a discussion of quadratic arithmetical forms, so ably expounded by Gauss in the "Disquisitiones Arithmeticæ." Such writers as Lejeune-Dirichlet, Eisenstein, and Stephen Smith added much to what Gauss had done, and a scholarly introduction to the whole theory was given by Mathews in his "Theory of Numbers" of 1892. A problem which arises in the theory of quadratic forms (the determination of the class-number) was the forerunner of the analytical theory which is intimately bound up with certain transcendental functions of a complex variable. It had little attraction for Mathews (though his book contains an introduction to it), but has recently received much attention from Prof. E. Landau, Prof. G. H. Hardy, and the late S. Ramanujan. The fourth stage was marked by Dedekind's discovery of his theory of ideal numbers, which restore completely to a system of algebraic numbers certain factorisation properties of ordinary integers that appear at first to be lost. Taking numbers of the type $a+b\sqrt{-5}$, where a, b are ordinary integers, a threefold factorisation of 21 is possible, viz.:

$$21=3\times 7=(4+\sqrt{-5})(4-\sqrt{-5})$$
$$=(1+2\sqrt{-5})(1-2\sqrt{-5}),$$

whereas none of the factors $3, 4+\sqrt{-5}$, etc., is decomposable into two factors $(a+b\sqrt{-5})(c+d\sqrt{-5})$.

Mathews' was probably the first mind in England to realise the far-reaching effect of Dedekind's discovery, two papers by him on the subject appearing in the London Mathematical Society's Proceedings of 1892. The tract "Algebraic Equations" on a kindred topic, written fifteen years later, contains a masterly exposition of Galois' theory, completed by Jordan and others, showing how the different types of irrationality which can be defined by an algebraic equation are associated with different types of group.

Written in collaboration with Prof. Andrew Gray, the "Treatise on Bessel Functions," concerned mainly with physical applications, is still a standard work. The "Projective Geometry" (1914), inspired by Henrici's lectures in London many years before, contains two unusual features: first, an exposition of the logical groundwork of the subject, and secondly, an account of Staudt's theory of complex elements (whereby a real involution defines a complex point or line). He also brought out a new edition of R. F. Scott's "Determinants" (1904), and contributed articles on *Number* and *Universal Algebra* to the 1910 edition of the "Encyclopædia Britannica."

Most of Mathews' mathematical papers appeared in the London Mathematical Society's Proceedings or in the "Messenger of Mathematics." A few of them are geometrical, and nearly all the rest have an arithmetical bearing. Pride of place, perhaps, should be given to a four-page note of 1897, in which he explained a method of reducing multiple partitions to a single partition. Several papers were written on the complex multiplication of elliptic functions, a subject which had a singular fascination for Mathews. The publication of a manuscript on the lemniscate functions has been delayed by the war and his subsequent illness.

Ever since the mid-eighties NATURE has published frequent reviews and articles from Mathews' pen. These articles, most of which appeared over the initials "G. B. M.," were always written in a careful and scholarly style; they contained his considered opinion on the book or point concerned. In conversation with the present writer he once expressed the opinion that some of his best work had appeared in NATURE reviews.

A man of simple tastes and naturally retiring by disposition, Mathews expressed sound judgment on both men and affairs. Some of his views, perhaps, were those of an idealist, and hardly feasible in the domain of practical politics. His capacity for maturely grasping everything with which his mind came into contact made him unique in the experience of his friends. Only one or two sides of so versatile a man's brilliant intellect really appealed to most people. When he was appointed professor of mathematics at Bangor, at the age of twenty-three, it was manifest that he could equally well fill four or more chairs in the college. During recent years he spent much time in reading and translating Arabic: he was also a competent musician.

W. E. H. B.

DR. J. T. MERZ.

DR. JOHN THEODORE MERZ, whose death on March 21, in his eighty-second year, was announced last week, was a son of Dr. Philip Merz, headmaster of the Chorlton High School, one of the pioneer institutions of higher education in Manchester. He was an acknowledged authority upon industrial chemistry and took a leading part in the industrial development of electricity supply, being one of the founders of the Newcastle-upon-Tyne Electric Supply Company. By the use of his great scientific and practical knowledge, he rendered invaluable service to the industrial community of Tyneside and the counties of Northumberland and Durham.

Dr. Merz will, however, be most widely remembered on account of literary activities, which go so far back as 1864, when he wrote a paper, which was published in Germany, on Francis Bacon, and another on Kant. For a long time the work by which he was best known was a small but much appreciated volume on Leibniz, contributed in 1884 to Blackwood's "Philosophical Classics for English Readers." A German translation of this appeared in 1886. These publications, however, were mere preliminaries to that which he had planned as the great work of his life, "The History of European Thought in the Nineteenth Century." The first volume of this was published in 1896, the fourth and last at the end of 1914. From the first

the wide-ranging history, learned but never dry, was a literary success, receiving praise from all sides and from thinkers of all schools. The impartiality with which the author treated the contributions made to thought by England, France, and Germany respectively was universally recognised. This work he was able to complete so far as scientific and philosophical thought are concerned. A third part to be devoted to the less systematic thought that has found its expression in *belles lettres* was projected, and was to consist, like the two parts on scientific and philosophical thought, of two volumes; but this Dr. Merz finally decided, though he had collected much material, must be left for some successor.

Dr. Merz's labours, however, did not by any means cease. At the end of 1915 he published a very interesting essay on Religion and Science, in which he showed that the certainty of science within its limits depends on its method of abstraction. A view of things "all together," in which the mind, without which the external world cannot be known, is restored as part of the total system of reality, leads to recognition of the religious attitude as a mode of comprehending the universe, including man. Philosophy mediates between science and religion, explaining the validity in its own manner of each mode of viewing things.

In a like essay, "Fragment on the Human Mind" (1919), Dr. Merz showed his freedom from some prejudices of that reaction in nineteenth-century English thought which had gone to Germany for a more spiritual doctrine than the native philosophy seemed to result in. Knowing and appreciating the rule of Kant and Hegel and their successors, in the end he found in the psychological method of Locke, Berkeley, and Hume the most valid, as well as the most accessible way to show the fallacies of the "mechanical Philosophy" when regarded, not simply as the most powerful instrument of scientific thought, but as revealing the ultimate nature of the universe. To give us a suggestion that reality is spiritual, Locke's "plain historical way," namely, the method of introspection, remains sufficient.

COLONEL SIR HENRY THUILLIER, K.C.I.E.

THE late Sir Henry Thuillier, who died on March 4, was Surveyor-General of India from 1886 to 1895, and was distinguished as an able and tactful administrator. His name is so generally associated with administrative work, that his success as a geodetic observer in the earlier part of his career is apt to be overlooked.

Thuillier was commissioned in the Bengal Engineers in 1857, the year of the Mutiny, and he was appointed to the Great Trigonometrical Survey of India in 1859. In 1859–1861 he was one of the observers employed in carrying a chain of principal triangulation round the Punjab frontier along the line of the river Indus; this chain has been the fundamental base of all the later surveys, which have been extended during campaigns into Afghanistan, Waziristan, and Tirah.

In 1862 Thuillier was appointed to the eastern frontier of India, and for the next six years he had the difficult task of extending the principal triangulation eastwards from Calcutta to Burma. During the first half of the nineteenth century the geodetic triangulation had been carried across mountains and plains, deserts, fields and forests, and the observers had had to adapt their methods of observation to the varying types of country; but in Eastern Bengal Thuillier encountered a type of country that had not been met with before, and which was probably the most unsuitable of all types for triangulation. He had to carry chains of triangles over the deltaic swamps of the Ganges and Brahmaputra; the country was absolutely flat and overgrown with heavy jungle.

Thuillier had to cut glades through the jungle so as to render the several stations of his triangulation mutually visible from one another. The party suffered continually from malaria; the clearing of the glades was so laborious that their width had to be limited to a few feet. The exact line in which any particular glade had to be cut from one station to another was not known with sufficient accuracy to enable the men to clear the jungle in the correct direction, and numerous trial glades had to be cut in order to determine the true alignment. In one year on the Brahmaputra series of triangulation, Thuillier had to clear 700 miles of glade through dense jungle, and in the six years the total length of the clearance lines was nearly 4000 miles.

Sir Henry Thuillier had also considerable experience of surveying at high altitudes. He was trained in the famous Kashmir survey of Montgomerie and Godwin-Austen (1861), and from 1870 to 1873 he was in charge of the survey of the Kumaun Himalayas, including the glacial areas of Nanda Devi and Trisul. Many of his survey marks were above 20,000 feet.

PROF. J. A. GREEN.

WE are grieved to hear of the sudden death, following upon an operation, of Prof. John Alfred Green, professor of education in Sheffield University. Many of us knew Prof. Green best in connection with the Educational Science Section of the British Association, of which he was for several years Recorder. He had the virtue we admire in a Tangye silent gas engine—converting all his energy into work and none into fuss—of a restrained enthusiasm, able to work in harness, but no less enthusiastic because he did not boil over into the vapid. Hence he was invaluable in the early days of the Educational Science Section, when many doubted whether there were, or could be, such a thing as educational science. But Prof. Green had visions and lived to realise them. He was secretary of the Committee on Mental and Physical Factors involved in Education, and the opening pages of the Report presented at Sheffield in 1910 make his attitude clear: "application of experimental methods to the investigation of mental phenomena" . . . "study of the persons to be educated and their attitude towards methods of instruction." If Section L still devotes a day annually to education and psychology, that is largely Prof. Green's doing. The work was carried further by him in *The Journal of Experimental Pedagogy*, which he edited. In that journal Prof. Green has left us a monument and a guidepost which may encourage us to go forward in the way which he was one of the first to tread.

H. R.

Current Topics and Events.

The Board of Trade announces that, in connection with the Safeguarding of Industries Act, judgment has been given by the referee in arbitrations regarding the following articles. Against the name of the article is shown the decision of the referee, *i.e.* whether it has been properly or improperly included in, or excluded from, the lists of articles chargeable with duty under Part I. of the Act:

Article.	*Judgment.*
Calcium Carbide . . .	Properly excluded.
R. Lactose	Improperly included.
Cream of Tartar, Tartaric Acid, Citric Acid	Improperly included.
Planimeters and Integrators (Planimeter type) . . .	Properly included.
Calculating Cylinders . .	Properly included.
Mucic Acid	Properly included.

In two cases, viz. that of R. lactose and that of cream of tartar, tartaric acid, and citric acid, the decisions are against the Board of Trade, and those substances are accordingly withdrawn from the lists of dutiable articles as from March 25, which is the date of signature of the awards. The *Chemical Age* of March 25 announces that an inquiry which should have opened into a complaint that barium peroxide had been wrongly included in the list had been decided by agreement between the producers and consumers. It is quite clear from these results that sufficient care had not been exercised by the persons concerned in drawing up the list in the first case, and if the announcement in the *Observer* of March 26, to the effect that the Board of Trade were to recommend the repeal of the Act, is correct, it would appear that the difficulties of working such a measure had become too great to justify its further continuance.

An exceptionally severe frost was experienced in most parts of England in the early morning of April 2, and the minimum temperatures reported to the Meteorological Office were in many places unprecedented for April. The temperature in the screen at Kew Observatory was 26°, which is the lowest April reading since observations commenced more than half a century ago. At South Farnborough, Hants, and at Benson, Oxon, the sheltered thermometer registered 21°. In consequence of the clear sky which prevailed the exposed thermometer fell generally about 10° below that in the screen, and at Shoeburyness the reading on the ground was 11°. At Greenwich Observatory the sheltered thermometer registered 25° and the terrestrial radiation temperature was 15°. The records at Greenwich, extending back to 1841, show only one instance of a lower temperature in the screen in April, the thermometer registering 23° on April 17 in 1847. There was a reading of 25° on April 1, 1859. Very heavy snowstorms were experienced in the south-western districts during the night of March 31 and on the following day, the ground being covered to a great depth. The storm was due to a disturbance moving from Cornwall across the English Channel. This storm area was followed by a region of fairly high barometric pressure which accompanied the cold snap.

The Council of the Optical Society is arranging a programme of papers dealing with motor head lights, having reference more particularly to the optical problems involved. The question of "glare" or "dazzle," and the methods proposed for overcoming it will be considered alike from the point of view of the optician, the lamp manufacturer, and the road user. The meeting will be held at the Imperial College of Science and Technology, South Kensington, on May 11, and any one desiring to contribute to the discussion, to exhibit models, or to give experimental demonstrations is requested to communicate with the honorary secretary of the Society, Mr. F. F. S. Bryson, Glass Research Association, 50 Bedford Square, W.C.1.

The *Times* announces that the Mount Everest expedition was to leave Darjeeling on March 26 for Tibet. Brig.-Gen. C. G. Bruce, chief of the expedition, was accompanied by Col. E. L. Strutt; Mr. G. L. Mallory, of last year's expedition; Dr. T. G. Longstaff; Maj. E. F. Norton; Dr. A. M. Wakefield; Mr. T. H. Somervell: Capt. J. Noel; Capt. G. Bruce; and Capt. E. J. Morris. Capt. G. Finch and Mr. C. G. Crawford remained behind to superintend the transport of the oxygen outfit upon which a great part of the success of the expedition depends. It will be noticed that the party is considerably larger than the one that made the successful reconnaissance last year. No trouble seems to have been experienced in enlisting porters among the hillmen. It is hoped that by April 6 the whole expedition will have assembled at Phari Dzong ready to set out and establish advanced bases in the Rongbuk and East Rongbuk valleys. A considerable time will be spent in training the porters in the use of ropes and ice axes and, in consequence, no delay is anticipated from the fact that the oxygen apparatus has not yet reached India.

For the purpose of carrying on the Ice Patrol Service provided for by the International Convention for the Safety of Life at Sea, the U.S. cutter *Seneca* has been detailed for duty off the Newfoundland Banks. According to the North Atlantic Meteorological Chart for April, this vessel was to go to sea in February 6 with orders to locate icefields and keep in touch with the drift of icebergs. About April 1, when the ice has moved well south, the U.S. cutters *Tampa* and *Modoc* will join the patrol, the three vessels continuing their work throughout the season of dangerous ice conditions. On getting in touch with the ice, the *Seneca* will report to the Hydrographic Office, New York, either direct or through any vessel within reach. Daily wireless messages will advise ships at sea. All messages will be sent in plain English. Masters of trans-Atlantic vessels are asked to report to the patrol vessels the location of icebergs or drift-ice and the temperature of the water every four hours between latitudes 39° N. and 48° N. and between longitudes 53° W. and 44° W. These data are required in order to ascertain the branches of the Labrador current.

A DEPARTMENTAL COMMITTEE has been appointed by the Minister of Agriculture and Fisheries "to inquire into the origin and circumstances of the recent outbreak of foot-and-mouth disease and into the policy and procedure which was pursued in dealing with the disease, and to report whether any alteration of the methods of administrative control hitherto adopted, or any amendment of the existing law, is necessary or desirable." The committee is constituted as follows: Capt. E. G. Pretyman (chairman), Mr. A. Batchelor, Mr. David Ferrie, Mr. F. W. Garnett, Mr. H. German, Mr. William Graham, Mr. Alfred Mansell, Sir G. Douglas Newton, Prof. J. Penberthy, and Mr. W. R. Smith. The secretary of the committee is Mr. S. A. Piggott, Ministry of Agriculture and Fisheries, 4 Whitehall Place, S.W.1, to whom all communications should be addressed.

THE British Rainfall Organization has removed its quarters from Camden Square, where its work has been carried on for more than half a century, to the Meteorological Office at South Kensington. For about three years the organization, which was formerly of a private nature, has been carried on as part of the official meteorological service of the country. It is thought that the general meteorological work will be greatly facilitated by being under the one roof in Exhibition Road, South Kensington. The Rainfall Organization was transferred from March 20. The absorption of the Meteorological Office in the Air Ministry has made it necessary for parts of the Office to be at the Air Ministry Offices in Kingsway. The office at South Kensington deals with climatology and instruments.

MR. ROBERT SARGEANT has retired from the Meteorological Office after rather more than 50 years' service. He entered the office in 1871 when it was controlled by a Committee of the Royal Society, at a time when ordinary weather forecasts, initiated by Admiral Fitzroy, had been discontinued. At that time weather reports were both received and published; they were used for the issue of storm warnings. Throughout the whole period of his service, Mr. Sargeant was engaged in the Daily Weather Report and Forecast Branch. He was also an Inspector of Meteorological Stations, and prior to his retirement had become Assistant Superintendent of the Forecast Branch. Mr. Sargeant's claim as a forecaster was based upon long experience and was chiefly associated with empirical rules; indeed, he is almost the last of a class which is being superseded by mathematicians and physicists who are working at the foundations of weather forecasting along strictly scientific lines.

THE number of journals entirely devoted to the study of earthquakes and volcanoes is small, and we welcome the publication of a new one, *Seismological Notes*, issued by the Imperial Earthquake Investigation Committee, Japan, and intended to contain preliminary reports on the Tokyo seismographical observations. To the first number Prof. Omori contributes two notes, one of which, on the great Chinese earthquake of December 16, 1920, contains reproductions of several Tokyo seismograms. He locates the origin in lat. 37° 5′ N., long. 106° 5′ E., a point close to several towns at which the shock was most disastrous, and between the centres of the great earthquakes of 1556 and 1561. The former of these earthquakes, by which more than 830,000 persons were killed, was probably the most disastrous of which we have any record.

THE third general meeting of the West Yorkshire Metallurgical Society, held in the City Museum, Leeds, on Saturday, April 1, took the form of a symposium of papers on the electric melting of metals; three original papers were read and discussed. The meeting was the last of a very successful winter session of this newly-formed metallurgical society. The membership, open to metallurgists, engineers, students, and others technically interested in the refining and working of metals, is steadily growing, and it is hoped that by next session the roll will contain a hundred members. The winter programme consists of meetings for the reading and discussion of papers in towns covered by the Society's activities, such as Leeds, Bradford, and Huddersfield. In addition to this and a summer programme comprising afternoon visits to works of interest to the members, the Society hopes to carry out suitably organised co-operative research through its members. The first president is Mr. T. E. Hull, and the hon. sec. is Mr. H. C. Dews, 17 St. John's Road, Huddersfield.

THE second annual report for 1921 of the Glass Research Association contains, in addition to the list of officers and members and its balance sheet, a statement of the problems already investigated and those under test. It appears that in addition to laboratories, now fully equipped, which the Association itself possesses at 50 Bedford Square, London, W.C.1, other institutions such as the National Physical Laboratory, the Department of Glass Technology, University of Sheffield, the British Refractories Research Association, and the Industrial Fatigue Research Board have all undertaken problems on behalf of the Association. Of the specific and definite results, one may refer to an investigation on the detection of cords in glass, the formation of "bloom" on lamp-blown glassware, the purification of mercury, the determination of the viscosity of a series of glasses over a limited range of (comparatively low) temperature, and the effect of the presence of chlorides and sulphates on the melting rate, working properties, and development of opalescence in lead glasses. On these subjects reports have appeared in the Bulletin of the Association. On the subject of glass-works practice, a new type of annealing lehr has been designed and erected, and a new furnace, an oil burner, and a cracking-off machine developed. References to other work and to research contemplated range over a wide field, but one of the subjects specially emphasised is that of glass refractory materials, and it is expected that co-operation with the British Refractories Research Association will carry forward investigations in this field speedily.

Messrs. A. Gallenkamp & Co., of Sun Street, E.C., have issued a catalogue of the latest forms of electrical resistance furnaces manufactured by them for various purposes. The heating element consists of a special alloy in the form of wire or strip, wound over a silica tube or muffle, and the furnaces are so constructed that the element may readily be removed by the user when burnt out, and replaced by a spare part. The maximum working temperature is 1000° C., and special types of furnace are made for the determination of carbon in steel, the estimation of ash in coal, the Lessing coking test for coal, and for organic combustions. The ordinary patterns are suited to such operations as the heat treatment of specimens of metals, the determination of the critical points of steel, and the checking of pyrometers against a standard. The power consumed by the furnaces when working at 1000° C. ranges from 400 watts for a tube 12 inches long and 1 inch diameter to 2300 watts for a muffle $14 \times 7 \times 4\frac{5}{8}$ inches. Details of accessories such as rheostats for controlling the temperature, ammeters, etc., are given, and the prices are also stated—a feature often absent from modern catalogues.

A number of reprints of communications made to the Edinburgh meeting of the British Association have been issued from the office of the Association in Burlington House, Piccadilly, W.1. We have received numbers 1-7 as follows: (1) Science and Ethics, by Dr. E. H. Griffiths, 9*d.*; (2) The Structure of Molecules, 9*d.*; (3) The Effects of the War on Credit, Currency, Finance, and Foreign Exchanges, 1*s.* 6*d.*; (4) Complex Stress Distributions in Engineering Materials, 3*s.* 6*d.*; (5) Charts and Pictures for Use in Schools, 1*s.*; (6) An International Auxiliary Language, 1*s.*; and (7) Report of the Conference of Delegates of Corresponding Societies, which contains Sir Richard Gregory's presidential address, "The Message of Science." It will be a great convenience to have these discussions and reports in pamphlet form, and it is to be hoped that the demand for these reprints will justify the Association in publishing similar reprints of contributions to future meetings.

Our Astronomical Column.

A Study of Obscure Nebulæ.—There have been many notes in recent years on regions of the sky where there is a deficit in the star-density as compared with neighbouring regions, the explanation generally assigned being an obscuring veil of dark nebulosity. We may refer in particular to one in Mon. Not. R.A.S. for November 1920 dealing with some barren regions in Taurus as shown on the Franklin Adams charts. Rev. J. G. Hagen, S.J., Director of the Vatican Observatory, has been examining these regions for the last ten years with the 16-inch refractor at the Observatory. He states that he can see these nebulosities, not as dark objects, but as faintly luminous ones. He discusses their distribution in *Scientia* for March; they are seen in all parts of the sky, but are densest towards the galactic poles, and diminish in extent and density as the galaxy is approached. He states that they are entirely absent in rich galactic star fields, and supposes that the nebulous material has been wholly transformed into stars in these regions. He places the obscure nebulæ outside the galaxy and asserts that their greater faintness in low galactic latitude is the result of greater distance; this does not appear to be sound, as the surface brightness of objects of sensible area is unaffected by distance provided that the intervening space is perfectly transparent. There is the further difficulty that in such barren fields as those in Taurus there is a deficiency not only of distant stars, but apparently also of nearer ones, suggesting a much smaller distance for the obscuring cloud. Thus while the visual study of these interesting regions is thoroughly useful work, there seems to be need of further examination of the significance of the results obtained.

Spectroscopic Study of Procyon's Orbit.—Dr. Lunt directs attention in *Astrophys. Journ.* for January to the aid that the spectroscope may render in the study of this system. The companion, discovered by Schaeberle in 1896, is a very difficult object and observations have been scarce of late. Dr. Lunt quotes the figures that he deduced from his measures on plates taken between 1909 and 1912. These appear to indicate a diminution in the approach of the principal star to the sun, which was 3·74 km./sec. in 1909 and 3·56 km./sec. in 1912; he points out that observations made now will be fairly decisive as to the pose of the orbit-plane, as there would be a difference of $1\frac{1}{2}$ km./sec. on the two assumptions. As one of the nodal passages is now at hand, the conditions are more favourable than they will be till 1938, when the other node is passed. He is himself arranging for a series of plates and asks for co-operation elsewhere. The approach of the centre of gravity towards the sun is given as 3·52 km./sec.; corrected for the sun's motion, the system is approaching with a speed of 19 km./sec. in a line inclined 14° to the line joining sun and star.

Recent Magnitudes of Novæ.—The appearance of a new star in the heavens at once attracts the attention of a large number of observers who follow very carefully the changes of magnitude and the variations in its spectrum. When, however, the magnitude has dwindled down to about 8 or 9, interest greatly diminishes; the star becomes too faint for spectroscopic analysis except with large telescopes, and the small and slow changes of magnitude are not watched by many observers. It is, however, very important to follow novæ so long as possible in order to keep in touch with the later variations. Great interest is, therefore, attached to the series of observations made by Dr. W. H. Steavenson of six novæ during the summer and autumn of 1921 (*Monthly Notices*, R.A.S., vol. 82, November 1921). Nova Ophiuchi (1848) gave evidence of variability in a period of about fifty days, the magnitudes varying from about 12 to 13. Nova Aquilæ (1918) is still slowly waning, the mean magnitude falling from 9·4 to 9·9, with a possible long-period variation. Nova Cygni (1920) is also still fading slowly, the mean magnitude during the period of observation falling from 9·4 to 10·0. Nova Cygni (1876), a star now very near the limit of visibility, exhibited practically a constant magnitude, namely, 14·81. The same is the case with Nova Lacertæ (1910), which has varied only 0·1 mag. from 14·1. On the other hand, Nova Persei (1901) has shown a marked variability of an irregular type, the two extremes of brightness being 12·27 and 13·36. The star was accompanied by a small patch of nebulosity about 5″ in diameter.

Research Items.

The Organism and Environment.—In an article on "The Organism and its Environment" (*Scientific Monthly*, March 1922), Dr. F. B. Sumner emphasises the difficulty of drawing any sharp line between these two categories. Citing as examples the nest of a bird, the tube of a caddis-worm, the shell of a mollusc or a tortoise, the varying fluids and gases which circulate in animals from sponges to fishes or seals, and the many metabolic changes of substances entering or leaving the body, he shows that the distinction between organism and environment must often be difficult or arbitrary. Some of his remarks have a direct bearing on the discussion of biological terminology which has taken place recently in this journal. Thus he says, "Every character has a hereditary basis" and is likewise due to "interaction . . . with the . . . environment." He goes on to say, "The familiar question, Which is the more important, heredity or environment? is not capable of answer when stated in that form"; he points out that the question should be framed on these lines: Are the *differences* between related organisms in any particular case due to *differences* in heredity or to *differences* in environment? When stated in this way it is seen that some characters or differences are primarily due to heredity and some to environment, and the quibble about all characters being equally acquired and equally inherited ceases to be of scientific value.

Studies on Arthropoda.—Dr. H. J. Hansen has issued, "at the expense of the Rask-Ørsted Fund," under the title "Studies on Arthropoda, I." (Copenhagen, 1921), three papers—one, illustrated with four plates, on a collection of Pedipalpi, etc., from West Africa, another on the post-embryonic occurrence of the median "dorsal organ" in Crustacea, malacostraca, and a third on stridulation in decapod Crustacea. In this last paper Dr. Hansen has brought together the records of the species of decapods in which stridulating organs are present, and gives an account of two further examples which he has discovered in a species of Ovalipes (one of the Portunidæ) and in Acanthocarpus (family Calappidæ). A stridulating organ consists usually of a regular row of small tubercles or a file-like series of ridges, *e.g.* on the carapace, which can be rubbed by a ridge, or a regular row of tubercles or ridges, or a sharp margin situated on some movable part of a neighbouring appendage. The sound produced by living crabs by means of the stridulating organ has been heard in the case of about half a dozen species. Dr. Hansen points out that a stridulating organ is developed in all species of Ocypoda except one, and in the Indo-Australian *Ocypoda ceratophthalma* one of the two series of ridges is composed of ridges of two sizes, coarse and very fine, so that the tone produced is deep or high, according as the coarse or fine ridges are rubbed. In discussing the use of the stridulating organ Dr. Hansen quotes Col. Alcock's view that this organ serves the crab to give warning to trespassers of its own species about to enter its burrow, but he suggests that some naturalist who has at his disposal living examples of Ocypoda should carry out investigations with the view of elucidating further the use of these organs.

Hygrometry.—The report of the discussion on hygrometry which was held by the Physical Society of London in November last has been issued with the Proceedings of the Society for February 15. It extends to 95 pages and is the most comprehensive publication on the subject which has appeared for many years. For some time one of the principal problems of hygrometry has been to develop a method which would determine, with an accuracy of 1 per cent., the fraction of saturation of air at temperatures below the freezing-point of water. The chemical method of absorbing the moisture is quite satisfactory at ordinary temperatures, but at temperatures below the freezing-point, the weight of moisture present is small and the method becomes difficult owing to the deposition of dew on the weighing tubes and other apparatus used. The dew-point method in its various forms is applicable at all temperatures and has been employed at the National Physical Laboratory as the standard of reference. The wet and dry bulb instrument fails at temperatures below the freezing-point, while the hair hygrometer continues to act although its indications are not always trustworthy. There appear to be some grounds for taking the decrease in length of the hair from its length when saturated as proportional to the logarithm of the relative humidity down to a relative humidity of 10 per cent.

Liquid Inclusions in Glass.—Some interesting experiments on the production of liquid inclusions in glass, made by Mr. Charles E. Benham, are described in the *Geological Magazine* for March. Although liquid inclusions in crystals of sodium chloride, alum, and other salts resemble in many respects those in quartz and exhibit Brownian movement of the more minute enclosed bubbles, there is reason to believe that their origin is not the same. Artificial inclusions approximating more closely to the cavities in minerals were prepared by boiling resin in water tinted with gamboge. Some of the cavities produced contained small quickly moving bubbles, and in others the gamboge particles were in rapid motion. In order to form similar artificial inclusions in glass approximating more nearly to those found naturally in quartz, a small glass tube about 3 inches long and a quarter inch external diameter was partially filled with water and sealed at both ends. It was enclosed within an unbaked brick and submitted to the usual process of firing in a brick kiln at a temperature of about 1200° C. After this treatment the glass was found to contain microscopic liquid inclusions with vapour bubbles comparable with those found in quartz. The experiment was repeated with similar results.

The Atomic Weight of Chlorine.—From the researches of Dr. F. W. Aston it is known that ordinary chlorine, atomic weight 35·46, is a mixture of two isotopes of atomic weights 35 and 37. The constancy of this ratio has been proved by the concordance between the determinations of the atomic weight made in different laboratories. This chlorine, without exception, came from minerals deposited by sea water. There is a possibility that the ratio might not be the same in chlorine arising from primary minerals not deposited from sea water, and this question has been taken up by Mlle. Ellen Gleditsch and B. Samdahl (*Comptes rendus*, March 13). They prepared salt from an apatite (calcium chlorofluophosphate) found in primary rocks, and after careful purification from fluorine, bromine, and iodine, found the atomic weight of the chlorine to be 35·49, 35·45, 35·46, the same as that of ordinary chlorine. Hence at the time of the formation of the minerals of the primary magma, the two chlorine isotopes were in the same ratio as at the present time.

The British Cotton Industry Research Institute.

THE new laboratories of the British Cotton Industry Research Association, at the Shirley Institute, Didsbury, Manchester, were formally opened by H.R.H. the Duke of York, K.G., on March 28. His Royal Highness was welcomed by the Chairman of the Council, Mr. Kenneth Lee, and the Director of Research, Dr. A. W. Crossley, in the presence of about 1500 guests, including representatives of most of the Universities. Mr. Kenneth Lee gave a brief review of the development of mechanical skill in the cotton trade, and explained how it was that the present leaders in the industry had become so convinced of the need for scientific inquiry on a large scale that, with the help and encouragement of the Department of Scientific and Industrial Research, they had established an Association for research on a co-operative basis. He spoke appreciatively of the help which University laboratories could contribute, and pleaded for their sympathetic co-operation, but he explained that the application of scientific methods and discoveries which were so much needed by the industry could be rendered most effectively by a group of scientific workers making their experiments in a special institution where they could obtain a closer knowledge of the processes involved than can be gained during an academic career.

His Royal Highness, in declaring the Institute open, congratulated the Association on securing the loyal support of the vast majority of the firms engaged in the industry and the various organisations of Labour, and emphasised the Imperial value of the close union which existed between the Research Association and the Empire Cotton-growing Corporation.

So far back as May 23, 1917, the opinion was expressed at one of the meetings of the provisional committee which organised the Cotton Industry Research Association that "the site of the Research Institute should not be less than five acres in extent; that it should be in pleasant surroundings, free from vibration due to traffic, and easily accessible both from the University (of Manchester) and from the centres of industry." These conditions are admirably fulfilled in the Shirley Institute, to which brief reference has already been made in Nature (1920, vol. cvi. pp. 411-413). The house and laboratories are nearly 250 yards from the main road, the grounds are bounded on the south by open fields, the prevailing winds leave the air free from the smoke clouds of both Manchester and Stockport, and the centre of the city can be reached in about half an hour.

The new laboratories have been designed to secure maximum adaptability, since it is almost impossible to predict which will be the predominant department in a few years' time. A "unit size" room has been created, and the separate laboratories are made in multiples of this unit. All the equipment is, so far as possible, uniform in design, and future extensions of the laboratories will be carried out on the same plan, so that the physics department, for example, could be moved to another portion of the building with the knowledge that all its furniture would fit into the new rooms.

Fig. 1.—The Shirley Institute for Cotton Research.

The ground plan of the new laboratories, representing two-fifths of the projected scheme, is given in Fig. 2. The completed portion is a one-storey building, divided into a central block 170 ft. × 54 ft., and an end block 83 ft. × 32 ft., the former being subdivided by the entrance hall and a long corridor into four departments each 22 ft. wide, which are partitioned off by breeze-block walls into one-, two-, or three-unit rooms as best adapted to the special requirements of the department. The outer walls, 21 in. thick, and the walls of the corridor bear the weight of the saw-tooth roof, which provides for north lighting. The span of each section of the roof is 10 ft. 6 in., and therefore the "unit room" is 22 ft. × 10 ft. 6 in.

All the supply lines, including 4-in. gas and water mains, hot-water, steam, and compressed air circuits, electric lighting and power cables, lead from the special battery of twenty two-volt "Exide" cells, and telephone wires are carried along a passage 5 ft. high under the central corridor. The branch lines for the different rooms of the central block are

brought under the floors, the secondary mains for gas and water being closed circuits with control valves at each end. The drainage pipes also pass first into the sub-floor, the height of which is 3 ft. 6 in., so that all vital supply and waste systems are accessible at any time. The laboratories are heated by radiators at the floor level, and hot-water pipes are also conveyed around the ceilings to prevent down-draughts from the glazed roof.

With the exception of the main chemical laboratory and balance-room, none of the rooms have fixed benches. In most cases the supply-lines and small sinks are held in position by a narrow shelf attached to the walls at the standard height of the window sills, and working accommodation is provided by tables of the same height, which are arranged in accordance with the needs of the work in progress. In the physics department stout battens are screwed to the walls at two different heights from the floors and the gas connexions and any apparatus which is to be mounted for a considerable time are attached to these battens. Fume cupboards, where necessary, are built into the window spaces, and mounted on wide concrete shelves covered with Ruabon tiles, the draught being induced by gas-burners placed in the flues at the floor level. Bright metal taps and electric switches have been avoided entirely so as to minimise the labour of cleaning.

The work of the botanical department is chiefly microscopical, and special attention has been given to various forms of artificial illumination. Each microscopist has at his disposal two gas leads, a small sink, an electric power point for microscope illumination, an electric lighting point for bench lamps, and low-voltage currents from overhead wires for warm-stage work and incidental illumination. A fire-proof and sterilisable room is reserved for bacteriology, and contains electric incubators and sterilisers mounted on concrete benches, and a gas autoclave under a ventilating hood. The department has a very large number of samples of cultivated and semi-wild varieties of cotton, and obtains further material for study from an experimental greenhouse in which about 300 cotton plants can be grown at one time. The physics department is fully equipped for research into the physical and mechanical properties of single cotton hairs, carded cotton, slivers, yarns, and fabrics. Each room is well supplied with electric power points, and is wired for six independent circuits from the battery. Two of the rooms, having concrete floors paved with wood blocks, are reserved for experiments with delicate pieces of apparatus which demand freedom from vibration. The main chemical laboratory, 40 ft. × 30 ft., is a very bright room with walls covered with white tiles up to a height of 8 ft. Furnaces, thermostats, and large pieces of apparatus are accommodated on a tiled, concrete shelf, and a special bench is reserved for distillations. The working benches, 27 ft. long, are made of pitch-pine with teak tops. Large glazed sinks are provided at each end, and the drainage from the taps and filter-pumps which range along the benches is taken by glazed channels. All the sinks discharge into loose mixing traps before emptying into the drains.

The importance of the subject of colloids for the cotton industry has been recognised by the creation of a separate department of colloid chemistry and physics. The three rooms are well equipped for physico-chemical research, one with a concrete floor being reserved for experiments which demand freedom from vibration or cause chemical fumes. Special accommodation for optical work is provided in a large room which has the roof lights completely obscured, the windows fitted with roller blinds, and all the walls, woodwork, and furniture painted a dead black. One corner of this room has been partitioned off and fitted as a photographic dark room, both parts being ventilated by a light-tight electric fan.

The coach-houses and stables of the estate have been converted into workshops for the construction and repair of instruments used in the laboratories and for the general maintenance of the Institute. Ample accommodation has been secured for smith's and carpenter's work and general machining on the ground floor, and for a scientific glass-blower above. These experimental workshops have already proved to be of enormous value to the Institute in equipping the new laboratories and making new devices for the testing of cotton yarns.

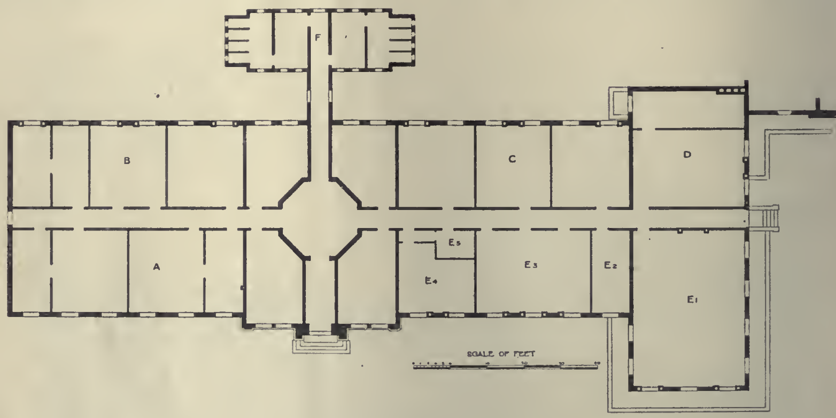

Fig. 2.—Ground Plan of New Laboratories.

A. Department of Physics.
B. Department of Botany
C. Department of Colloids
D. General Stores.
E_1. Main Chemical Laboratory.
E_2. Balance Room.
E_3. Unoccupied.
E_4. Optical Room.
E_5. Photographic Dark Room.

Below D is the boiler-house, and under E_1 a machinery room.

The National Institute of Industrial Psychology

A LARGELY attended meeting of the National Institute of Industrial Psychology was held at the Mansion House, London, on March 27, at which the principal speakers were Viscount Haldane, Mr. W. L. Hichens (Chairman of Messrs. Cammell Laird & Co., Ltd.), and Dr. C. S. Myers (Director of the Institute). The chair was occupied by Mr. H. J. Welch (Director of Messrs. Harrisons and Crosfield, Ltd., and Chairman of the Institute). The following resolution, moved by Dr. Myers and seconded by Mr. Hichens, was carried unanimously:

"In view of the present serious economic situation and of the necessity to reduce costs of production and to increase the total national output, this meeting is of the opinion that: (*a*) a more complete and scientific development of the nation's human resources and a reduction of wasteful and misapplied energy are matters of urgent national importance; (*b*) the methods adopted by the National Institute of Industrial Psychology have been shown to reduce costs of production, to promote the development of individual ability, to eliminate unnecessary effort and fatigue, and to improve the health and well-being of the worker; (*c*) it is imperative that a national fund should be immediately established to enable the institute to extend its sphere of usefulness and to continue the necessary researches into the scientific problems involved."

The following letter was read from Mr. Seebohm Rowntree: "I am sorry I cannot be present, for I should have been glad of an opportunity to speak of the services of the institute to the cocoa works at York. We have felt for some time that benefits would accrue if some of the human factors affecting efficiency were studied on a more scientific basis. . . . It was a great advantage to be able to turn to an institute like yours and to secure from you not only a trained worker to make actual observations among the workmen, but the services of a skilled psychologist to direct him. It has shown us how important are the researches still to be made in our own factory by psychological experts."

Mr. Harry Salmon (Managing Director of Messrs. J. Lyons and Co., Ltd.), in proposing a vote of thanks to Viscount Haldane for his address, expressed his pleasure and satisfaction at the work carried out by the institute in the factories and depots of his firm. The output of the packing department of the chocolate factory had been increased by over 35 per cent., and at the same time the amount of effort and fatigue of the workers had been reduced. Similar results were being obtained in other departments of the firm.

Dr. Myers emphasised the value to the employees of the institute's work. Many workers, he said, have expressed their gratitude spontaneously to the investigators for the reduced fatigue felt at the end of the day. The form of the daily output curves before and after the investigations has actually demonstrated the reduction in the workers' fatigue.

The institute, he said, also aims at guiding the young worker in the choice of his occupation, submitting him to detailed examination by applying to him a series of mental, physical, and medical tests, and considering the results in conjunction with school records. These tests serve also to guide the employer in selecting the most capable applicant for a vacant post. They are not intended to replace the ordinary interview, but to supplement it by the measure they afford of the candidate's general intelligence, and of his endowment with the special abilities required for the particular job. The institute has already, thanks to the investigations of Mr. Cyril Burt, formulated satisfactory tests for shorthand writers and typewriters. Mr. Muscio's tests for selecting compositors, published by the Industrial Fatigue Research Board, have proved equally valuable.

In the United States numerous bureaux of vocational guidance are scattered over the whole country. Occupational tests are to-day being applied in America for the selection of sales clerks, proof-readers, clerical workers, inspectors, assemblers, and other types of factory workers. Mental tests have been introduced in place of, or as complementary to, the ordinary entrance examinations in several important universities of America. At the Carnegie Institute of Technology in Pittsburgh (in the University of which there are over 2000 students of psychology) the Bureau of Personnel Research is maintained financially by a number of industrial and commercial firms, who thus obtain information relating to the selection, training, organisation, and supervision of their personnel. Single firms or groups of firms arrange with the Carnegie Institute for special research on the problems arising in their factory, office, sales, or executive organisation. Instruction and research on vocational psychology are carried on in most of the American universities.

In Barcelona, the Institute of Vocational Guidance is supported entirely by the city and by the province of Catalonia. Over a thousand applicants for advice pass through its hands every year. In Brussels a similar rate-supported vocational guidance bureau is doing most valuable work, abolishing the huge number of occupational misfits and thus reducing not only the vast expense of a needlessly large labour turnover but also the overstrain and unhappiness of the misguided worker. In Germany laboratories concerned with industrial psychology and physiology have been established in Berlin, Frankfurt, Leipzic, Munich, and other large centres. The Allgemeine elektrische Gesellschaft, the Osram Company, the Berlin Tramways, Siemens and Halske may be mentioned among the firms which have availed themselves of the services of such institutes, especially in the selection of workers in their principal departments. It is stated that during twelve months the Grosser Berliner Strassenbahn has saved over twelve million marks as a result of the application of vocational selection, proper training based on motion study, etc. Indeed, Germany hopes to secure a lead in commerce and industry by paying attention to their *human* aspect, just as in pre-war days she advanced by paying attention to their *material* aspect. Her trade unions are likewise recognising the value of vocational guidance and of systematic training in approved methods of work.

Viscount Haldane, in the course of an eloquent address, stated that there was no problem more menacing than that of unrest arising out of the relations of Labour to Capital. We had reached a stage at which the merely mechanical work was being done more and more by the machine, while the worker was becoming more and more engaged in the directing of the machine. In other words, mind was becoming of ever-increasing importance; indeed it was not capital that created wealth, nor labour, but mind. One of the objects of the institute was, so far as possible, to relieve labour from the feeling that men and women were only machines. The aim of the institute was not to secure increased output at all costs to the worker, but to improve the mental, physiological, and physical conditions under which he worked and by this means to increase his efficiency. We were beginning to realise that the workman,

although he is not a machine, needs to be studied with the same scientific care and methods as are now applied to a machine, and within twenty years, he imagined, the expert in psychology and physiology would be at the elbow of every manager of a great business. If this were done we should have taken a step towards securing the contentment of the workers, because they would, at the end of their day's work, be fresh enough to turn their attention to that spiritual refreshment and knowledge which would give them the full meaning of life.

Gas Cylinders Research.

THE first report of the Gas Cylinders Research Committee has just been published by the Stationery Office. The Committee was appointed in 1918 to inquire into the whole question of cylinders for the storage and transport of compressed gases other than acetylene, but the present report deals only with the material for cylinders for the so-called permanent gases which are not liquefied at the pressures prevailing in the cylinders. The main question under discussion was the advisability of using steel of higher carbon content than has hitherto been permitted in this country, the regulations based on the recommendations of the 1895 Committee requiring that the carbon should not exceed 0·25 per cent., whilst in America the carbon may be as high as 0·55 per cent. The railway companies favour the continuance of this restriction, arguing that the immunity of this country from cylinder accidents as compared with foreign countries points to the desirability of using only low-carbon steel. On the other hand, it is shown that cylinders of steel containing 0·43-0·48 per cent. of carbon have given perfectly satisfactory tests at the National Physical Laboratory, and that such cylinders are at present carried by road, whilst the railways conveyed a large number of hydrogen cylinders of this composition during the war under an indemnity from the Admiralty.

The Committee was not able to arrive at a unanimous decision. Eleven of the members sign the main report, in which steel of the higher content in a normalised condition is recommended as an alternative material, the stress tests and tests for toughness being specified. The chairman, Prof. H. C. H. Carpenter, and the scientific members of the Committee are agreed on this point. The dissenting member, Mr. J. H. B. Jenkins, is of opinion that high-carbon steel is not only less tough, but also more liable to variations in quality than mild steel, and that the saving in weight which would be effected by the change is too small to justify even a slightly increased risk of accident. The report contains a long account of mechanical tests and microscopical examinations, and will be found of interest by all steel metallurgists, whether they are concerned with the immediate problem or not.

University and Educational Intelligence.

ABERDEEN.—At the spring graduation ceremony on March 30 the honorary degree of doctor of laws (LL.D.) was conferred upon Prof. T. W. Griffith, Professor of Medicine, University of Leeds; Mr. John Masefield; and Dr. C. H. Turner, Dean Ireland's Professor of Exegesis, Oxford. The following higher degrees were also conferred. *Science: D.Sc.*, G. P. Hector, Agricultural Department, Dacca, India. Thesis—"Studies in the Botany and Genetics of Rice." *Medicine: M.D.*, F. W. C. Brown. Thesis—"A Critical Investigation into the Thermal Death Point of the Tubercle Bacillus in Milk, with Special Reference to its Application to Practical Pasteurisation." J. G. Danson. Thesis—"Anaphylaxis: its Relationship to Asthma and Hay Fever." M. Y. Garden. Thesis—"Observations on the Treatment of Diseases of the Lungs and Pleura by Artificial Pneumothorax." R. D. Lawrence. Thesis—"The Estimation of Diastase in Blood and Urine and its Diagnostic Significance." *Ch.M.*, Dr. W. Brander. Thesis—"Spontaneous Rupture of the Pathological Spleen."

LONDON.—The following doctorates have been conferred:—*Ph.D.* (*Science*) on Mr. J. Mould for a thesis entitled "The Properties of Dielectrics, including the Variations of Dielectric Constant with Frequency, the Energy dissipated therein and the Variation in Conductivity," and on Mr. G. Sheppard for a thesis entitled "Contributions to the Geology of Southern Alberta and Saskatchewan, Canada, with detailed reference to the Stratigraphy and Structure of the Foothill Belt and its Associated Areas"; and *Ph.D.* (*Economics*) on Bal Krishna for a thesis entitled "Commercial Relations between India and England."

The Lindley Studentship, of the value of 120*l*., offered every third year, will be awarded to assist research in physiology in the physiological laboratory. Candidates should submit a statement of qualifications and the mode of research proposed to the Academic Registrar by May 1.

Three Research Studentships for post-graduate work, of the value respectively of 175*l*., 105*l*., and 75*l*. (with remission of school fees in addition), and available for two years, will be awarded in July next by the London School of Economics and Political Science. Applications, upon a special form obtainable from the director of the school, Houghton Street, W.C.2, must be sent in by, at latest, May 31.

MANCHESTER.—A Fellowship for the encouragement of research in preventive medicine has been instituted in memory of the late Auguste Sheridan Delépine, professor of public health and bacteriology in the university from 1891 to 1921, by the addition of the emoluments of the former Junior Research Fellowships in Public Health to the interest derived from an endowment of 1000*l*., made by Dr. Charles Slater of Tunbridge Wells. The regulations which have now been approved provide for a Fellowship of 300*l*., to be offered biennially and to be open for competition by candidates who are graduates in medicine of this or any other approved university, or who hold an approved registrable medical qualification.

The Ashby Memorial Research Scholarship in Diseases of Children, value 100*l*., is being offered this session. Applications for the scholarship, with information as to the subject proposed for investigation and the qualifications of the candidates, should reach the Internal Registrar of the university before June 30.

WE referred in these columns on March 6, p. 325, to a scheme put forward by the Colston University Research Society, of Bristol, for the establishment of Colston Research Fellowships in the University of Bristol. Already the Society announces that Messrs. J. S. Fry and Sons, Ltd., Messrs. E. S. and A. Robinson, Ltd., and Messrs. C. Thomas and Bros., Ltd., have each promised to contribute the 150*l*. annually necessary to found Fellowships. It is to be hoped that the lead given by these firms will be quickly followed by other local manufacturers.

Calendar of Industrial Pioneers.

April 7, 1898. Otto Baensch died.—For nearly fifty years Baensch was in the State service of Germany and did important work in connection with the navigation of the Elbe, the Upper Rhine, and the famous Kaiser-Wilhelm or Kiel Ship Canal.

April 8, 1893. Vice-Admiral E. Paris died.—Joining the French Navy in 1822, Paris was one of the first naval officers in France to study steam navigation. He wrote manuals on mechanics and a treatise on screw propulsion, and contributed papers to the Institution of Naval Architects, of which he was elected an honorary associate.

April 9, 1870. Thomas Joseph Ditchburn died.—A pioneer builder of iron ships, Ditchburn received his training in Chatham Dockyard and assisted Sir Robert Seppings in some of his experiments. He afterwards was manager for Fletcher and Fearnall, and then with Mare established the first iron shipbuilding yard on the Thames. In 1846 he built the only iron sailing man-of-war ever in H.M. Navy, H.M.S. *Recruit.* Ditchburn later on founded the famous Thames Iron Works at Blackwall, where during ten years he constructed some 400 vessels.

April 9, 1877. William Gossage died.—A great industrial chemist and inventor, Gossage began life as a druggist's assistant. In 1830 he assisted to found an alkali works at Stoke Prior, Worcestershire, and six years later he patented his well-known condensing tower which prevents the escape of hydrochloric acid gas; an invention "which saved from extinction a trade, the growth of which has contributed to the nation's prosperity." Gossage engaged in copper smelting and other enterprises and also became the largest manufacturer of soap in the world.

April 10, 1903. Horace Bell died.—Entering the public works department of India in 1862, Bell rose to be Engineer-in-chief of the Survey of the Great Western Railway of India and consulting engineer for the State railways.

April 11, 1822. Ralph Dodd died.—The projector of a tunnel beneath the Thames between Tilbury and Gravesend, Dodd was a civil engineer and was known for his writings on canals and on the water supply and docks of London; he was also a promoter of steam navigation. He died just a hundred years ago from injuries sustained by a boiler exploding.

April 11, 1847. Charles Holtzapffel died.—The son of a German toolmaker who settled in London in 1787, Holtzapffel became an expert mechanician, and in 1843 published a valuable work entitled "Turning and Mechanical Manipulation." He was a member of the Council of the Institute of Civil Engineers.

April 12, 1840. Franz Anton von Gerstner died.—Like his father a mathematician and engineer, Gerstner from 1818 to 1825 was professor of practical geometry in the polytechnic in Vienna, and was one of the earliest continental railway engineers. He constructed the railway from Budweis to Linz, and in 1834 built the first Russian line, that from St. Petersburg to Czarskoeselo. He died in Philadelphia, whither he had gone to study the railways of America.

April 12, 1898. Aimé Claude Alfred Girard died.—A distinguished French chemist, and a member of the Institute, Girard in 1871 succeeded Payen in the chair of industrial chemistry in the Conservatoire des Arts et Metiers. E. C. S.

Societies and Academies.

LONDON

Royal Society, March 23.—Sir Charles Sherrington, president, in the chair.—Sir Richard **Glazebrook**: Specific heats of air, steam, and carbon dioxide. The values for the specific heats of these gases below 1000° C. given recently by Womersley are higher by 5-10 per cent. than those which follow from the results given by Holborn and Henning.—A. E. H. **Tutton**: (1) Monoclinic double selenates of the manganese group. The manganese group of double selenates of the isomorphous series $R_2Mn(SeO_4)_2 \cdot 6H_2O$ includes only three salts, those in which R is rubidium, cæsium, and ammonium. Optically these salts are precisely in line with those for analogous salts of other groups, so that if the potassium salt could be obtained, it would be the first member of a progressive series, and the general law of progression of the crystallographic properties with the atomic number of the alkali metal would be obeyed rigidly. The volume and edge-dimensions of the space-lattice cells of the crystal structures of ammonium manganous selenate hexahydrate and rubidium manganous selenate are nearly identical. Similar facts obtain for all analogous ammonium and rubidium salts throughout the whole isomorphous series, as well as for the rhombic simple sulphates themselves. (2) Monoclinic double selenates of the cadmium group. Crystals of the ammonium salt, $(NH_4)_2Cd\ (SeO_4)_2 \cdot 6H_2O$, which were sufficiently transparent in parts for optical use were obtained on very keen frosty nights. The potassium salt appears to be incapable of existence, its limit being probably below 0° C. Crystals of the rubidium or cæsium salt were obtained during the coldest nights of January, but they were quite opaque, so that only goniometrical measurements were possible. The results are in complete accord with those from other, complete groups.—F. A. **Freeth**: The system: $Na_2O—CO_2—NaCl—H_2O$. The system is arbitrarily considered as composed of two four-component systems, namely:—$Na_2CO_3—NaHCO_3—NaCl—H_2O$, and $Na_2CO_3—NaOH—NaCl—H_2O$. Determinations have been made at 0°, 15°, 20°, 25°, 30°, 35°, 45°, and 60° C. A general treatment is given showing how the composition and quantities of the stable phases from any mixtures of the components may be deduced.—M. A. **Catalán**: Series and other regularities in the spectrum of manganese. Flame-arc, arc and spark spectra of manganese have been observed and new series lines traced. Series belonging to the spectrum of the neutral atom are (*a*) a system of triplet series; (*b*) a system consisting of narrow triplets; and (*c*) a system of narrower triplet series running parallel to the preceding system. Intercombination lines between the two first systems appear as two lines very prominent at low temperatures. The calculated ionisation and resonance potentials of manganese are 7·4 volts and 2·3 volts. Diffuse triplets in the spectrum of the ionised atom are composed of nine lines. At different temperatures, groups of lines of the same character and related by very exact numerical separations ("multiplets") have been identified. The neutral atom of manganese probably has two electrons in the outermost ring, and when it loses one electron and becomes ionised, another electron comes out to the ring. Thus, the spectra of neutral and ionised atoms would be similarly constituted in accordance with observations.—D. W. **Dye**: Calculation of a standard of mutual inductance and comparison of it with the similar laboratory standard. The windings of the primary helices and the secondary overwound coil of a Campbell type of mutual inductance standard were measured in terms

of the length standards of the N.P.L. and the value in absolute millihenries has been calculated. Comparisons with the similar laboratory standard at a frequency of ten cycles per second showed that the ratio of the calculated values of the two standards was in agreement with the ratio of the experimentally compared values to an accuracy of 5 in 10^6.—P. E. **Shaw** and N. **Davy**: The effect of temperature on gravitative attraction. Results with a torsion balance of the Boys-Cavendish type indicated a temperature effect of gravitation of about 1×10^{-5} per 1° C. With similar apparatus modified to eliminate small mechanical movements caused possibly by the raising of the large gravitative masses to a high temperature, the effect was shown to be due to such movements reversible with temperature. The temperature effect, if any, must be less than 2×10^{-6} per 1° C. The mean effect observed is a very small diminution in attraction as temperature rises.

Zoological Society, March 7.—Sir Sidney F. Harmer, vice-president, in the chair.—N. S. **Lucas**: Report on the deaths which occurred in the Society's Gardens during 1921.—R. **Broom**: On the temporal arches of the Reptilia.—F. V. **Urich**, H. **Scott**, and J. **Waterston**: The bat-parasite *Cyclopodia greeffi*, and a new species of hymenopterous (Chalcid) parasite bred from it.—S. V. **Montgomery**: Direct development in a Dromiid Crab.—F. **Balfour-Brown**: The life-history of the water-beetle, *Pelobius tardus*, Herbst.

March 21.—Dr. A. Smith Woodward, vice-president, in the chair.—P. Chalmers **Mitchell**: Monkeys and the fear of snakes.—G. **Blaine**: Notes on the zebras and some antelopes of Angola.—R. I. **Pocock**: On the external characters of some Histricomorph Rodents.—H. R. **Hogg**: Some spiders from South Annam.

Physical Society, March 10.—Dr. Russell, president, in the chair.—R. L. **Smith-Rose**: On the electromagnetic screening of a triode oscillator. The most complete method of screening a valve set is to enclose it in a hermetically sealed box made of metal of suitable thickness for the frequency used. The smallest crack allows a detectable amount of the high-frequency energy to escape. Iron is far more effective than copper of the same thickness in preventing direct penetration of radio-frequency magnetic fields through the metal.—H. P. **Waran**: A new form of high vacuum automatic mercury pump. The pump, based on a modified Sprengel action, works automatically, the mercury being removed from the lower to the upper reservoir mixed with a current of dry air which is sucked through a side tube by a filter pump. An intermediate reservoir in the middle of the fall tube, kept automatically exhausted by the Sprengel action in the lower fall, allows the upper half to exert a positive exhaustion for every pellet of mercury falling down. The absence of compression in the first fall makes it possible to use the maximum bore for the fall tube. Less than a pound of mercury is required to operate the pump.—W. N. **Bond**: Viscosity determination by means of orifices and short tubes. General expressions for the end-corrections obtained by the method of dimensions are employed in plotting the results of experiments on the flow of mixtures of glycerine and water through pairs of tubes of equal diameter, but of different lengths. The conditions that the flow at the ends may be purely viscous and equations for determining the viscosity are given.

Royal Meteorological Society, March 15.—Dr. C. Chree, president, in the chair.—E. M. **Wedderburn**: Seiches; and the effect of wind and atmospheric pressure on inland lakes. "Seiche" is the name originally given in Switzerland to quasi-tidal movements of the level of inland lakes. In 1905 the late Prof. Chrystal investigated the seiches in Loch Earn for the Scottish Lake Survey, and found that microbaric disturbances were the most frequent cause of seiches. Other possible causes are heavy rainfall over part of the lake, rapid flooding and wind squalls. Earth tremors rarely cause considerable movements. The Scottish Lake Survey also discovered internal seiches of large amplitude. During autumn there is at the surface a layer in which there is little variation of temperature with depth. Below this is a narrow layer, the discontinuity layer, in which the fall of temperature is rapid, while below this again is the bottom water of the lake in which temperature variations are small. The effect of wind blowing along a lake is to accumulate the warm surface water at the lee end, so that the discontinuity layer is displaced from its normal horizontal position. When the wind moderates a standing oscillation commences at the discontinuity layer. The period of oscillation depends on the difference of density between these layers; the amplitude may be several feet, without causing measurable disturbance of the level of the free surface.

CAMBRIDGE.

British Mycological Society, March 18.—Mr. F. T. Brooks, president, in the chair.—Mrs. M. N. **Kidd**: Diseases of apples in storage. Moulds attacking apples in storage show a definite sequence and cause a different amount of loss. Physiological diseases are of considerable importance. Scald and probably others can be completely controlled by wrapping the fruit in specially prepared paper.—J. **Line**: Parasitism of *Nectria cinnabarina*. This fungus is associated with a characteristic wilting of apparently healthy branches, the wood of which is brown to green and occluded with fungal hyphæ. Pure cultures of the fungus were incapable of establishing the hyphæ in living wood or cortex but succeeded on artificially killed plants, and finally were able to pass into healthy wood.—K. C. **Mehta**: Observations on the occurrence of wheat rusts near Cambridge. *Puccinia graminis* does not overwinter by uredospores nor by mycelium inside the host plant; its recurrence is explained only through fresh infection by æcidiospores produced on Barberry. In *P. triticina* and *P. glumarum* viable uredospores can be found during the greater part of winter, and there is conclusive experimental evidence that these rusts can overwinter by means of mycelium inside the host plants.—F. T. **Brooks** and C. G. **Hansford**: Mould growths on cold store meat. Meat from the southern hemisphere showing mould growths was investigated. Some of these fungi, particularly *Cladosporium herbarum* ("black spot"), can develop at -6° C.; other moulds grow readily at temperatures about freezing-point. At several degrees above this, bacterial growth is so active as to suppress the moulds. The fungi are only superficial and, unless accompanied by putrefactive bacteria, do not render the meat unfit for food.

DUBLIN.

Royal Dublin Society, March 28.—Dr. J. A. Scott in the chair.—J. J. **Nolan** and J. **Enright**: Experiments on the electrification produced by breaking up water, with special application to Simpson's theory of the electricity of thunderstorms. Different samples of water were tested. The purer water gives higher charges, the difference being very great for small degrees of breaking-up. With more complete pulverisation the charge produced tends to be

independent of the purity. It is found that the purer water can be broken into finer drops. Charges are obtained about ten times as great as any reported previously. The probable charge produced by the natural breaking up of a rain-drop of 4 mm. diameter is 0·2 e.s. unit per c.c.

EDINBURGH.

Royal Society, March 20.—Prof. F. O. Bower, president, in the chair.—Address by Sir Charles **Sherrington**: Some points regarding present-day views of reflex action. More attention is being paid now than formerly to the intimate nature of the processes in the nervous centres during reflex action. The question has been raised as to whether the essential elements of reflex action as unfolded in the reflex centre itself contain any which are fundamentally different from the properties shown by simple peripheral nerve-muscle preparations. The resemblance between the neuro-muscular junction and the synapse suggests that the latter, like the former, is a junctional region exhibiting decremental conduction of the nervous impulse. Then much of the summation observable in the nervous centre could be accounted for by such timing in the sequence of centripetal impulses that the successive impulses fell in the conducting path at such frequency as to coincide with the period of supranormal phase in the conducting fibre. The larger impulses thus resulting would pass through the decremental block that suffices to extinguish smaller ones. A somewhat slow frequency of stimulus rhythm would thus succeed in making a stimulus effective which had been at the outset ineffective. Conversely a frequency of serial stimuli, each singly effective, but so timed as to follow one upon another at such interval as to fall within the period of relative refractory phase of the precedent impulse, would lead to impulses of subnormal extent. These on arriving at a region of decrement, a synapse, would fail to pass. A neurone occupied by such subnormal impulses would form a complete inhibitory block to any reflex arc of which it formed a link. Thus central inhibition could be established by successive impulses, the interval between which lay outside the period of absolute refractory phase but not so far outside as to escape that of relatively refractory phase. Lucas offers an explanation of reciprocal innervation by such rhythmic impulse adjustments as involve interference of impulses of this nature. By invoking changes in the degree of decrement in the decrementally conducting regions the reversal of reflex action can be explained. Thus A. Forbes accounts for the changing of reflex excitation into reflex inhibition by assuming that the intensity of decrement is increased by such agents as chloroform and ether. The similar reversal by fatigue lends itself to a similar explanation. Such properties, observable in the simple nerve-muscle preparation itself, can be made to explain the main essential features of action of the nerve-centres.

PARIS.

Academy of Sciences, March 6.—M. Emile Bertin in the chair.—The secretary announced the death of M. Max. Nœther, correspondent for the section of geometry.—G. **Julia**: New applications of conformal representation with functional equations.—H. **Villat**: A new problem concerning analytical functions and conformal representation. — R. **Lagrange**: The application of varieties of order p in an x space of n order.—B. **Gambier**: Point correspondence deduced from the study of the three fundamental quadratic forms of two surfaces.—A. **Planiol**: Organic yield of internal combustion motors.—G. **Camichel**: Surfaces of discontinuity.—C. **Nordmann** and **Le Morvan**: Observation of a singular phenomenon presented by the star θ of the Great Bear. From its spectrum, this star should belong to the solar type, but the intensity distribution in its spectrum corresponds with an effective temperature near that of the very hot hydrogen stars.—G. **Prévost**: Determination of the coefficients in the development in Laplace polynomials of a function of two variables.—M. **Labussière**: The geometrical existence of a general invariant of pencils of rays refracted according to Descartes' law, and its applications to geometrical optics and to radiation.—E. **Belin**: The telegraphic transmission of photographs, drawings, or manuscripts. The original is converted into a relief photograph on bichromate gelatine paper, and a stylus connected with a microphone is moved over this relief. Special arrangements are described for ensuring the synchronism of the transmitting and receiving mechanism. The efficiency of the apparatus has been proved by trials in America and in France.—G. **Claude**: The elimination of the heat of reaction in the synthesis of ammonia at very high pressures.—G. **Chaudron** and G. **Juge-Boirard**: The estimation of sulphur in iron pyrites. In the method in current use (solution in aqua regia) some sulphur occasionally separates. It has been found that by allowing the reaction to proceed at the ordinary temperature for 12 hours this error can be avoided. — H. **de Pommereau**: The reduction of ethyl benzoate and of some other benzene compounds by sodium and absolute alcohol. With ethyl benzoate the chief product is tetrahydrobenzylic acid, with a small proportion of tetrahydrobenzyl alcohol as a secondary product.—M. **Sommelet** and J. **Guioth**: The formic hydrogenation of the quaternary salts of hexamethylenetetramine. Hexamethylenetetramine chlorbenzylate boiled with formic acid gives a slow evolution of carbon dioxide. When gas ceases to be evolved, dimethylbenzylamine, $C_6H_5 \cdot CH_2 \cdot N(CH_3)_2$, can be isolated, in quantity corresponding with 60-70 per cent. of the theoretical yield.—A. **Allix**: Observations on relief sculpture by ice.—A. **Guilliermond** and G. **Mangenot**: The signification of the reticular apparatus of Golgi. It has been suggested that Golgi's apparatus has no real existence in the living plant and is caused by the preparation and staining of the section. With barley root as material, Golgi's experiments were repeated and confirmed, using not only Golgi's method, admittedly open to objection, but also the more certain technique of Cajal and Da Fano.—P. **Georgévitch**: The origin of the centrosome and the formation of the spindle in *Stypocaulon scoparium*.—Mme. A. **Pruvot**: A new and remarkable type of Gymnosome (Loginiopsis). A description of a new type of Gasteropod collected during the voyages of the Prince of Monaco in the region of the Azores. At the point where the mouth is usually situated this animal carries an appendix, in length about one-third that of the body. This is expanded near the summit into three fleshy lobes.—F. **Maignon**: The utilisation of the tissue diastases for the determination of the organ, the functional insufficiency of which is the cause of a pathological state. The application of this clinical method to the study of the physiological *rôle* of certain organs. Basedow's disease was proved to be caused not by the condition of the thyroid gland alone, since a mixture of diastases from the thyroid, ovary, and suprarenal glands was required to abate the symptoms. Eczema yielded to treatment with hepatic diastases, either alone, or mixed with diastase from other organs.—J. **Benoit**: The physiological conditions relating to the periodic nuptial adornment in birds. There is a close connection between the

state of the testicular interstitial gland and the state of the nuptial adornment (change in colour of plumage). There is no such connection between the nuptial adornment and the intratubular seminal gland.—C. **Oberthür** and C. **Houlbert**: Convergence or parallel variation in the genus Holimede.—M. and Mme. G. **Villedieu**: Contribution to the study of anticryptogamic copper mixtures. The spores of Phytophthora (potato "disease") germinate freely in solutions of copper bicarbonate, but solutions of sodium sulphate (0·18 per cent.), potassium chloride (0·15 per cent.), sodium chloride (0·15 per cent.), or potassium nitrate (0·2 per cent.) arrest completely the germination of mildew. It would appear that the presence of copper in Bordeaux or Burgundy mixtures is of doubtful utility.—M. **Aron**: The determinism of secondary sexual characters in Tritons.—P. **Nottin**: The increased solubility and diastatic degradation of the nitrogenous materials of maize. Application to yeast manufacture.

Official Publications Received.

Department of the Interior: United States Geological Survey. Forty-second Annual Report of the United States Geological Survey to the Secretary of the Interior for the Fiscal Year ended June 30, 1921. Pp. 108. (Washington: Government Printing Office.)

Thirty-fifth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1913–1914. (In 2 parts.) Part II. Pp. viii+795-1481. (Washington: Government Printing Office.)

Annual Report of the Director, United States Coast and Geodetic Survey to the Secretary of Commerce for the Fiscal Year ended June 30, 1921. Pp. 147+36 charts. (Washington: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1921, No. 8: Foreign Criticism of American Education. By W. J. Osburn. Pp. 158. (Washington: Government Printing Office.)

Diary of Societies.

FRIDAY, APRIL 7.

DIESEL ENGINE USERS' ASSOCIATION (at Institution of Electrical Engineers), at 3.—H. Moore: Some Characteristics of Petroleum Oil used in Diesel Engines.

LONDON SOCIETY (at Royal Society of Arts), at 4.30.—Dr. C. W. Saleeby: More Light on London: or the Coal Smoke Curse and the Restoration of Daylight.

FOOD EDUCATION SOCIETY (at Caxton Hall, Westminster), at 5.30.—Miss A. D. Muncaster, and others: Discussion on Feeding in Institutions, with special reference to School Diet.

ROYAL AERONAUTICAL SOCIETY (Students' Section) (at 7 Albemarle Street), at 6.45.—Prof. L. Bairstow: Some Aeronautical Problems of the Early Future.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—J. W. Maple: Engineering in Southern Persia.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: Evolution of the Elements.

SATURDAY, APRIL 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (6).

INTERNATIONAL COLLEGE OF CHROMATICS (at Caxton Hall), at 3.15.—E. K. Robinson: Trees: their Colours and Coloration.

MONDAY, APRIL 10.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—T. Roberts: Seven Decisive and Suggestive Scenes in the History of the Secular Contest between Conscience and Power.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—C. S. Fox, and others: Discussion on Dr. Heron's Report on the Geology of the Mount Everest Region.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.1), at 8.—Dr. G. E. Moore, Prof. G. Dawes Hicks, and Miss L. S. Stebbing: Discussion on Dr. McTaggart's "Nature of Existence."

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ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—A. Millar: Galicia and its Petroleum Industry.

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ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Capt. T. A. Joyce: The Paquecha of Ancient Peru.—Miss A. C. Breton: Notes on Some Peruvian Antiquities.

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INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—A. F. Evans: Marine Engine Design as affected by Lifeboat Service Conditions.

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MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society).

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NATURE

SATURDAY, APRIL 15, 1922.

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Oxford and Cambridge and the Royal Commission.

THE original application for Parliamentary grants, which led to the appointment of the Royal Commission on Oxford and Cambridge Universities, came in 1919 from the heads of the scientific departments of Oxford. Not only were the immediate needs stated and the provision necessary to enable work to be continued, as it had been carried on before the war, but also a great development of the departments was foreshadowed with increasing difficulties in the absence of outside assistance. The Commissioners take the view that a great opportunity has come for Oxford science greatly to strengthen its position if the University and Colleges will take determined action and if funds can be made available. Far from accepting the idea that Cambridge should be allowed to develop as a "Science" University while Oxford becomes still more pronouncedly the home of the "Humanities," the Commissioners emphasise the great value of the "juxtaposition, intellectually and socially, of the best minds in diverse subjects, and the constant interaction of the Humanities and Science on one another." Accepting this point of view completely, we propose to examine their report to see how it will help the full development of science in the two universities.

Foremost in the changes recommended by the Commissioners we place for this purpose the proposals with regard to fellowships. The development in the range and character of university studies has not been accompanied by a corresponding growth in the number of college fellowships available for distinguished teachers. At Cambridge, where on the whole the newer subjects are much more strongly placed than at Oxford, there are university professors for whom no college fellowships are available. The recommendation of the Commission to create fellowships without stipend in the colleges for senior university officers—for whose stipend the university is responsible—both meets this anomaly and leaves vacancies in college fellowships for younger teachers and researchers. Many college societies will be greatly strengthened by the additions that they will thus be able to make to their body. And here we might say that it would have been a great gain to Oxford and All Souls College alike if the Commissioners had made specific provision for the inclusion of scientific studies among those to be supported by that college. Co-ordination between the University teaching by Faculties and the college teaching by tutorial supervision will be improved under the proposed scheme. The Commissioners make very few revolutionary proposals, preferring to build on the sure foundations laid by tradition and experience, and they recognise the great value of the personal contact of the college tuition in Oxford and Cambridge. But difficulties have arisen and will arise between self-governing colleges choosing their own teachers and university faculties controlling departments of study, and the Commissioners have hit on a happy solution of the problem. Colleges retain their freedom to select their own staffs but are penalised financially if a fellow elected to a teaching post is not acceptable to a University Faculty for the position of University Lecturer or University Demonstrator.

Closely tied with the proposals about official fellowships is the scheme for increasing the number of unofficial research fellowships. Coupled with an increase in the number of studentships in the Universities, which would become possible if the recommendations of the Commission as to grants is adopted, this scheme will increase greatly the development of post-graduate research work in the Universities. The Commissioners rightly lay great stress on the importance of this, but point out that it must be impracticable unless the number of teachers is increased and the directors of research are freed from some of the heavy burden of routine teaching. Each proposed reform in turn falls back upon the imperative need for financial assistance: the recommendation of a grant of 100,000*l.* a year to each university in place of the present grant—now become a recurring grant—of 30,000*l.* will have to be accepted before any large proportion of the Commission's proposals can be put into action.

Certain sections of the Commission's report do not deal directly with science but call for brief mention here. The present control of the University by Convocation or the Senate is to be greatly restricted. Congregation or the House of Residents—University

and College officers—is to be the ultimate authority, its decision being checked, in the event of a strong opposing minority, by an appeal to the larger body of non-residents. A second affirmative vote by the resident body is, however, to be decisive. Unless a minority recommendation, signed by two of the Cambridge committee, calling for immediate Parliamentary action is adopted, the position of women at Cambridge is left for decision by the new House of Residents. The Commissioners do, however, support a scheme for full membership, with restriction in numbers to 500,—essentially scheme A rejected by the Senate in December 1920. Special grants, earmarked for the women's colleges, of 4000*l.* a year to each University for a period of 10 years should be a great help to them in their present financial difficulties and a great incentive for a renewal of appeals for benefactions from the public.

Other special grants recommended are 6000*l.* a year to each University for the development of the valuable extra-mural teaching, and special arrangements are suggested for allowing selected adults to join the University without passing the entrance examination to be imposed on all ordinary undergraduates. The importance of the non-collegiate body of students is emphasised as being economical, especially suitable for certain types of students and historically the oldest form of residence in both places. The minimum cost at Oxford in 1920, in cheap lodgings of non-collegiate residence, including board and lodging, is given in the report as 65*l.*

A summary of the report has already appeared in our columns (April 1, p. 428). It is impossible to enter here into all the important questions raised as to the cost of living and the regulations as to college finance. It is equally impossible to conclude this article without reference to the enthralling historical survey of the growth of the Universities with which the report opens.

The First European Civilisation.

The Palace of Minos: A Comparative Account of the Successive Stages of the Early Cretan Civilisation as Illustrated by the Discoveries at Knossos. By Sir Arthur Evans. Vol. 1, *The Neolithic and Early and Middle Minoan Ages.* Pp. xxiv + 721 + 18 plates + plans, etc. (London: Macmillan and Co., Ltd., 1921.) 6 guineas.

THE excavations at Knossos were described by Sir Arthur Evans in detailed reports which appeared in the Annual of the British School at Athens from 1900 to 1905, and were reviewed from time to time in these columns. For years afterwards he and his adjutant, Dr. Mackenzie, were engaged in supplementary work, which involved much digging, in addition to the laboratory processes of cleaning, restoring, and classifying an enormous mass of finds. The history of successive rebuildings was unravelled, and the sequence of pottery-types verified by new trial-pits. Meanwhile discoveries on other sites have filled gaps and supplied chronological data, so that the rise of Cretan civilisation can be correlated step by step with that of Egypt. The magnificent volume before us is the first of three in which Sir Arthur Evans proposes to embody his mature conclusions; it covers two of the three main periods into which he divides the Cretan Bronze Age, and the introduction includes an outline sketch of the whole course of Minoan culture. Much of the material, as of the interpretation, is new. The book is abundantly illustrated, with plans and sections by Mr. Theodore Fyfe and Mr. C. C. T. Doll, drawings by the two Gilliérons, Mr. Halvor Bagge, and Mr. C. T. Lambert, and many excellent photographs. Even more impressive than the extent of the excavation is the skill with which it has been carried through. One wishes that this enterprise, to which the author has so long devoted his private fortune and his unrivalled insight into prehistoric problems, had been more liberally backed by public subscription.

In a notice such as this, one can touch only on a few aspects of the story which the author unfolds. He emphasises the continuity of Cretan civilisation; "from the earliest Minoan stage to the latest there is no real break such as might be naturally explained by conquest from abroad." The Neolithic strata at Knossos are 23 ft. deep, the accumulated debris of several thousand years. If the incised pottery and nude female idols recall those of Anatolian sites, this points to a common heritage rather than to intercourse between distant tribes. Over a vast area of Europe and Western Asia the same low level of rude culture had endured for many centuries without notable progress. The sudden quickening of the Cretan stock which made their island the cradle of European civilisation, came from pre-dynastic Egypt. "It may well be asked whether, in the time of stress and change that marked the triumph of the dynastic element in the Nile Valley, some part of the older population may not have made an actual settlement on the soil of Crete"—a daring hypothesis which future discoveries may confirm; the south coast and western half of the island have been little explored and certainly hold surprises in store.

Pre-dynastic stone vases seem to have reached Knossos before the accession of Menes, for which the author accepts Eduard Meyer's date, 3315 B.C.

"E.M. I.," the First Early Minoan sub-period (roughly 3400–2800), sees the transition from stone to copper implements, and from copper to bronze. On the isthmus of Hierapetra, a short cut across the island for early trade, we meet with rectangular, many-roomed houses of sun-dried bricks framed in timber, with roofs of reeds and clay such as the peasants there still use. In the next stage (2800–2400) the walls are protected with plaster containing 40 per cent. of carbonate of lime; Mr. Noel Heaton's analyses show how this developed into the fine white stucco of almost pure lime on which the fresco-painters worked a thousand years later. Knossos was now importing diorite bowls from Egypt, and imitating them in liparite brought from the Æolian Islands north of Sicily; otherwise this period is scantily represented there, and the author draws freely on the graves found by Mr. Seager at Mochlos, rich in finely wrought jewelry and vases of variegated stone. Gold eye-bandages anticipate the gold masks worn by the dead warriors of Mycenæ, and a votive double axe shows that Minoan religion had already chosen its characteristic emblem.

In "E.M. III." (2400–2100) the centre of interest shifts to the fertile plain south of Mount Ida. Sir Arthur Evans publishes a series of ivory seals found in "tholos" tombs of this region by Dr. Xanthudides, the Cretan Inspector of Antiquities, the motives of which include apes, lions, scorpions, and meander-patterns, carved by native hands, but closely related to designs current at this time in the Delta. From a similar deposit, excavated by Prof. Halbherr, came a seal on which the author recognises an adaptation of the Egyptian draught-board sign (Fig. 1) with draughtsmen of characteristic form, and he is able to assign to this period some three- and four-sided bead seals with scenes from daily life. Before the close of this period huge works were being undertaken at Knossos; a round subterranean chamber, hewn to a depth of 53 ft. below the rock-surface, and entered by a step-way curving about its circumference, shows remarkable constructive skill.

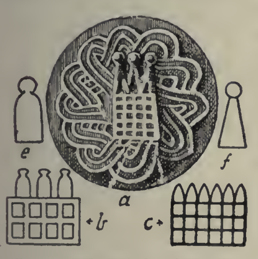


Fig. 1.—*a*, Draught-board and pieces on E.M. III. ivory signet (Fracture restored). *b*, *c*, Early types of Egyptian draught-board sign (*men*). *e*, *f*, Egyptian pieces. From "The Palace of Minos at Knossos."

Whatever their purpose, this and another "hypogæum" (as yet unexcavated) were disregarded when the First Palace was built in the First Middle Minoan period (2100–1900). It was the Age of Palaces. Alike at Knossos and at Phaistos there rose a great complex of state-apartments, sanctuaries, and store-houses; both were laid in ruins by some catastrophe, due to invasion or revolt, at the close of "M.M. II." (before 1700), and both were rebuilt with greater splendour soon afterwards, to be overthrown again at the close of "M.M. III." (about 1580). The Late Minoan phases, in which the art of Knossos attained its acme and declined, lie outside the scope of this volume.

From "M.M. I." onwards Knossos seems to dominate Crete. The buildings about the central court were planned with an eye to defence, notably the tower-like "Early Keep" which flanked the north entrance and had deep dungeons or store-pits in its basement. The neighbouring Peak-sanctuary on Mount Iuktas, frequented at this period, yielded votive offerings like those of Petsofà, above Palaikastro; these "high places" seem to have been sacred to the Mountain Mother, the supreme deity of Minoan religion, worshipped in the Palace as the Snake-Goddess. The remodelling of the Palace in "M.M. II." suggests elaborate provision for the ritual purification of those who entered it; from the first it was a sanctuary, ruled by priest-kings, who drew revenues in kind from large territories and exported oil and other produce to Egypt. The gay-coloured "M.M. II." pottery is dated within narrow limits by finds at Abydos and Kahun, and it may be that Cretan workmen settled at Kahun and worked for the Pharaohs, and even that the very ancient wharves and breakwaters off the island of Pharos, near the later site of Alexandria, which have been explored in recent years by M. Jondet, were constructed by Minoan engineers. Cretan art owed some of its technical accomplishment to this intercourse, but developed on its own lines, tending more and more to naturalism.

After the destruction of Knossos and Phaistos at the close of "M.M. II." a new dynasty took control, as the author infers from the introduction of a new linear script, not a direct outgrowth of the hieroglyphic system, and new methods of sealing; but the sacred character of the Knossian palace persisted, and a large part of the six acres which it covered was devoted to "lustral basins" (the "bath-rooms" of earlier reports), "pillar-rooms," and shrines. The state-apartments of the period, built on the hill-side east of the central court, are preserved to a height of two stories; the excavation of this region, and its reconstruction by the substitution of new beams and pillars for the carbonised ancient timbers, were feats of which Sir Arthur Evans and his staff may be proud. The elevation of the Grand Staircase (Fig. 2) illustrates the spacious dignity of Minoan architecture at its best. Of the fresco-paintings two examples are reproduced in colour, but the larger pieces are reserved for a Knossian Atlas to be published hereafter. Other colour-plates represent the faïence Snake Goddess, the famous inlaid draught-board of ivory, gold, and

crystal, and the polychrome pottery which in "M.M. II." attained a marvellous perfection of both form and design, but fell off in the succeeding period when other arts, notably that of the gem-engraver, were making rapid progress. Apparently the growing wealth of the new dynasty provided an abundance of table-ware in more precious materials, and pottery "was nothing accounted of"; the same cause led to the formation of a Palace Treasury in the west wing. Some of the magazines were walled off, and a series of lead-lined strong boxes was built under their floors. All were plundered when the palace was sacked, only scraps of gold foil and fragments of inlaid caskets being left. The author shows that the richest of the Mycenæ shaft-graves belong to this period, and that their contents, gold, silver, and faïence, may be part of the spoils of Knossos.

The book lights up many other problems; it makes known an early art of extraordinary freshness and beauty, and since it justifies in detail the "Minoan" system of classification and nomenclature, it lays a broad foundation for future research.

R. C. BOSANQUET.

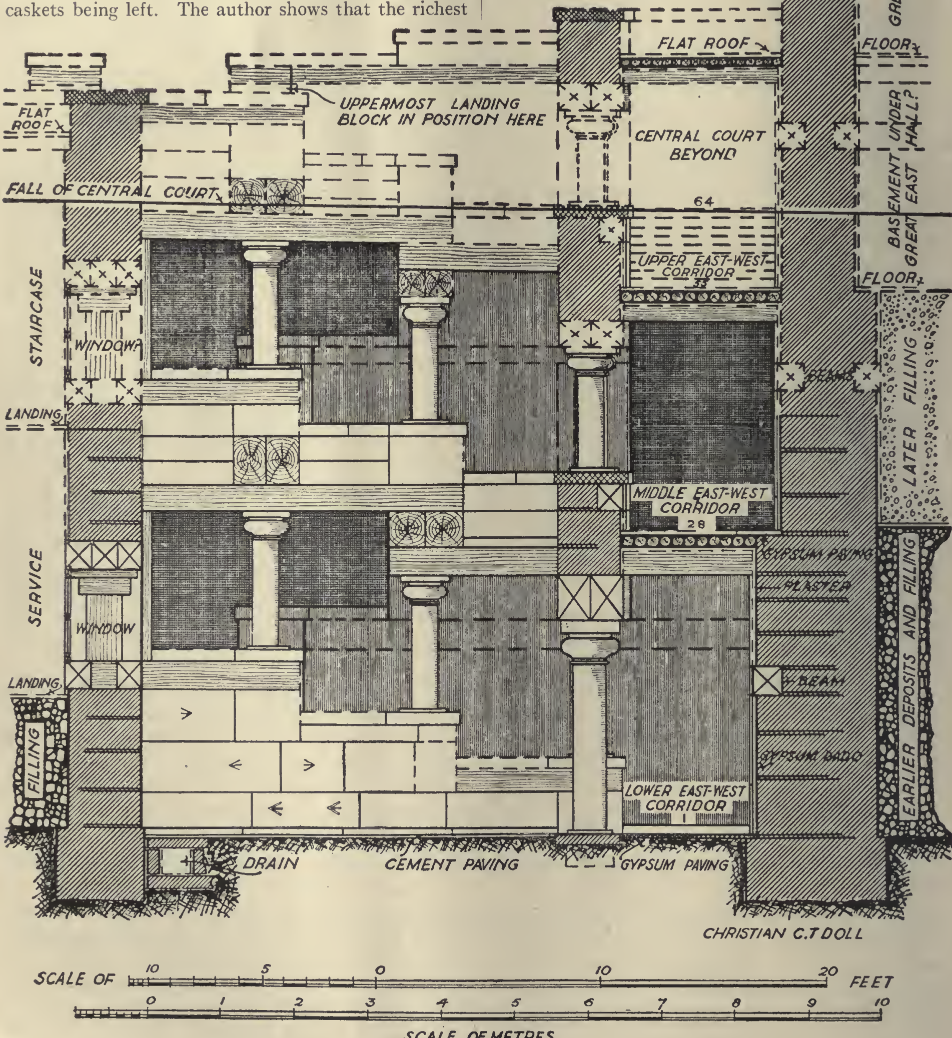


FIG. 2.—Reconstructed Elevation of the Grand Staircase at Knossos. From "The Palace of Minos at Knossos."

Turbulence as a Meteorological Agency.

Die Zirkulation der Atmosphäre in den gemässigten Breiten der Erde. Grundzüge einer Theorie der Klimaschwankungen. By A. Defant. Pp. 209-266. (Stockholm: Geografiska Annaler, 1921.)

THE study of turbulence as an agency of direct numerical importance in meteorological phenomena had its beginning before the war in the investigations of Åkerblom Hesselberg, G. I. Taylor, Barkow and W. Schmidt, and it is not surprising that it should have been developed independently on either side of the front during the war: on one hand by Taylor, L. F. Richardson, F. J. W. Whipple, D. Brunt, and H. Jeffreys, and on the other hand by W. Schmidt, F. M. Exner, and A. Defant. On both sides there has been the recognition of a common mathematical form of transmission upward or downward, through the agency of turbulence, of various elements with numerical coefficients that can be measured without entering into the details of the process by which the transmission is effected.

With us the study has been specially useful as applied to the eddy motion recognisable in winds and fogs, which is due to the friction of the ground and to the consequent deviation of the surface wind from the geostrophic wind; while on the other side the conception has tended to the general law of "Austausch," the passage upward or downward of heat or momentum in consequence of the ascertained conditions of equilibrium of adjacent columns. Both groups in different ways have come to recognise that transference by irregular turbulent motion is a principle of very general application, and that turbulence may range step by step, perhaps discontinuously, from the ultra-microscopic scale of molecular turbulence which we measure as viscosity to the gigantic scale of the eddy motion of the great cyclonic depressions or even of the general circulation of the whole atmosphere. L. F. Richardson has expressed the generality in a manner which easily sticks in the memory:—

> Big whirls have lesser whirls that prey on their velocity;
> They again have smaller whirls, and so on to viscosity.

In course of time we may have a view of the same idea of the universality of the ways of eddy motion from the Japanese point of view. The present article is concerned with an attempt on the part of Prof. A. Defant of Innsbrück to use the turbulence of the cyclonic depressions of middle latitudes to explain the distribution of temperature over the earth's surface and suggest explanations of climatic oscillations without entering at all into the details of the turbulent motion by which the effects are produced. It is an important and suggestive chapter in a new volume of meteorological theory. It deals with *turbulente Strömung grossen Stils*, a greater scale than has been used hitherto. Its basis is an extension of Schmidt's idea of Austausch of mass, and its accompanying properties in the vertical, to the Austausch of mass in a horizontal surface along meridians in consequence of the turbulent horizontal motion which is expressed by the irregular barometric changes in middle latitudes, between 40° N. and 70° N. These are the first stages of smaller whirls on the back of the great general whirl, and we read, with some curiosity as to the further development of the next following stages, "Alle Druckstörungen pflanzen sich mit derselben Fortpflanzungs Geschwindigkeit der aussertropischen Zirkulation."

With the aid of an equation, belonging to what is now a recognised family, a formula is obtained for the normal flow of heat across a vertical square centimetre near the ground which. with an Austausch coefficient A equal to 10^8 gcm.$^{-1}$sec.$^{-1}$ gives a flow of heat northward of 100 gram calories per sq. cm. per minute. The value of A is supported by the integrated components of wind, north and south, at Potsdam, and we are allowed to infer that the general circulation of the atmosphere west to east goes on all the time and is crossed by a flow alternately north and south due to turbulence which on the average of the year gives the numerical result specified.

From that conclusion Defant proceeds to calculate the disturbance of surface temperature for latitudes north of 30° from the balance which would result from radiation alone; thence to calculate the distribution of temperature when the turbulence is taken into account and to compare the results with Hann's normal mean temperatures for successive latitudes. Finding that a uniform value for the coefficient of Austausch gives notable discrepancies, he adjusts the coefficient to bring calculation and observation into agreement, and thus arrives at the following values for A: 10^8 at lat. 30°, 5×10^8 from 40° to 65°, and $1{\cdot}7 \times 10^7$ at 85°, with intermediate values for the intermediate latitudes; agreement being thus obtained, he claims that the variation of turbulence with latitude gives a satisfactory picture of the conditions so far as he knows them.

Having thus arrived at an explanation of the steady state, he proceeds to discuss the effect of a sudden permanent increase of temperature in the intertropical belt, such as might be assumed to represent the effect of the activity of sun-spots. He finds that the Austausch would cause a corresponding change of diminished amplitude with little difference of phase in more

northern latitudes, and finally discusses periodic alterations of the three elements upon which the distribution of temperature must be based, namely, the temperature of the intertropical belt, the radiative power of the air, and the intensity of the general circulation. He thus outlines a general theory of climatic changes.

The processes of reasoning are mathematical, and are set out with exemplary clearness; in order to get numerical results a great number of assumptions are necessarily made. So long as the discussion is confined to the consideration of the earth as a whole and normal temperatures are treated as a simple function of the latitude, a good deal of liberty may be allowed in the other assumptions; but when we get to close quarters with current meteorological experience some of them will naturally need adjustment. It seems odd that in dealing with periodic changes the best known periodic change from winter to summer did not challenge the author's curiosity. It seems nearer at hand than the influence of sunspots or Brückner's cycle.

The justification for using the Austausch A as a numerical symbol of the effect of the whole irregular atmospheric motion of middle latitudes would be complete if it could be shown that its measure from time to time would do instead of the study of the motion itself. From that point of view the winds at Potsdam can be regarded only as a beginning, and not a very good one. The winds at Bergen would certainly tell a very different story. The next step appears to be a closer examination of some data for Austausch.

One more point is noteworthy. Prof. Defant is apparently under the impression that in consequence of the conservation of momentum winds of 300 m./sec. are a meteorological possibility from the occurrence of which we are saved by the turbulence of middle latitudes. What we thought to be the causes of our worst gales appear as our safeguard against being blown away completely by winds of tenfold velocity. But in our practice we have become accustomed to regard winds as inevitably related to pressure differences. Prof. Marvin, of the United States Weather Bureau, has recently pointed out that the idea of winds of 300 m./sec. is one of the common fallacies about the atmosphere that not even the *cognoscenti* have escaped, and that in face of the "geoidal slope" they could not occur, turbulence or no turbulence. It is, therefore, a little disconcerting to find that Prof. Defant deploys the power of the Austausch to destroy them: disconcerting for this reason, that we are apparently put in possession of an engine that is powerful enough to reduce winds of 300 m./sec. to 20 m./sec. if it were wanted, and it is not wanted. What then becomes of its power? Has the power of the engine been over-estimated, or has it other work to do?

It is true that Prof. Defant's remark is merely an *obiter dictum*, and has no influence upon his reasoning; but the same idea stares one in the face from the diagrams of Ferrel, J. Thomson, and others, and is quoted by more recent authors. It is time it was cleared off the field of meteorological theory.

Napier Shaw.

Forensic Chemistry.

Forensic Chemistry. By A. Lucas. Pp. viii + 268. (London: Edward Arnold and Co., 1921.) 15*s*. net.

Mr. A. Lucas, who is the director of the Government Analytical Laboratory and Assay Office, Cairo, claims that his book is the first of its kind in English, with the possible exception of a small work on legal chemistry which he published in 1920, out of which the present work has grown. In a limited sense the claim may be valid, although the distinction between forensic chemistry and forensic medicine, on which latter subject there are many well-established treatises, is one of degree rather than of kind. Hitherto works on forensic medicine have included forensic chemistry. The expert on forensic medicine has usually been a medical man with knowledge and experience of the detection of chemical substances, such as poisons, which may form the subject of criminal investigation. Strictly speaking, the two branches are, however, perfectly distinct, and there has been a growing tendency within recent years to differentiate them. The criminal who contemplates murder, for example, has far more means at his disposal nowadays than formerly. Science has furnished him with methods unknown to former generations, and these can be combated and checked only by methods of science. It was inevitable, therefore, that public security should require the establishment of a special class of expert whose duty should be the study and application of methods of detection and recognition by chemical means of the many agents and appliances which may now form the subject of criminal inquiry.

But forensic or legal chemistry, as Mr. Lucas points out, may be concerned not only with examinations for the presence or absence of particular substances, such as poisons, but with questions which are only partly chemical, as the examination of blood-stains, questioned documents, counterfeit coins, fibres and textile fabrics—in fact, any problem of criminal

investigation in which chemistry may be of service in the administration of justice and with which medicine as such may have little or no concern.

Mr. Lucas's book, as might be expected, is largely based upon his experience of the methods of the criminal of the East, who, although he may not have all the appliances of his Occidental *confrère*, is scarcely less resourceful. Indeed, some of the instances of ingenuity and cunning to which Mr. Lucas incidentally refers may be recommended to the notice of writers of detective stories. Invested with all the glamour of the Orient, they would form a new departure in that class of literature.

The book is eminently practical, although it omits details of manipulation and methods of examination to be found in standard treatises on chemical analysis. It presupposes, in fact, that the chemist who embarks on the subject of forensic chemistry is a well-trained analyst with a sound knowledge of general chemistry. At the same time, it gives in detail the special methods needed by the expert. In a short introductory chapter the author offers very wise advice on the practice of forensic chemistry, evidently based upon personal experience and a wide reading of notable trials. Legal procedure, it must be admitted, is at times eminently unscientific. It might be supposed that the practice of the law would tend to the cultivation of the scientific spirit in its practitioners, but observation shows that this is far from being uniformly the case. This fact constitutes a difficulty with which the chemical expert has occasionally to contend. The rules of conduct which Mr. Lucas lays down may enable him to meet it. The value of the expert's testimony depends largely upon the manner in which he presents it and upon the soundness and extent of knowledge with which he is able to support it. The lengths to which cross-examination may go are almost limitless, and side-issues may be developed which require wide and accurate general knowledge to deal with satisfactorily. At the same time, the forensic chemist must never forget that he is not an advocate or a partisan; his single object should be to assist the court to a just decision.

Every kind of criminal investigation with which the chemist may be called upon to deal, such as the testing of blood-stains, the analytical examination of bullets and other projectiles for firearms, of clothing, counterfeit coins, documents, explosives and explosions, fibres, finger-prints, fires and firearms, poisons and narcotics, etc., is covered in Mr. Lucas's book. As regards blood-testing in legal cases, the author rightly insists that it should be undertaken only by those who have considerable experience of the work. The sources of error are frequently many, and the issues may be most serious. The chapter dealing with this subject is an excellent example of the care and caution with which the author approaches any question of chemical jurisprudence. Dealing with projectiles, it is only necessary to recall the Monson trial to realise how much may depend upon the analytical examination of projectiles, wads, and cartridges, the number and width of marks made by the rifling of the barrel, the direction of its twist, the presence of rust, etc. As regards clothing, the author shows how the examination of a waistcoat led to the detection and conviction of a German spy during the war of 1914–18.

Counterfeit coining seems to be very prevalent in Egypt. The coins are usually struck, and many, we are told, are excellent imitations. A few illustrative cases are given, some of which display considerable ingenuity in adapting primitive appliances and apparatus intended for other purposes. The examination of suspected documents in cases of substitution or forgery may require the testing of the paper for the nature of the fibre, the recognition of water-marks, the analysis of the ink employed, the style of pen used, etc. Cases met with in Egypt evidently present difficulties not usually present in European countries.

Knowledge gained during the war has undoubtedly led to a great extension of the use of high explosives for criminal purposes, especially in the form of bombs as a means of assassination, and the chemico-legal expert is not infrequently called upon to examine them in connection with attempts at murder. Such examinations are, of course, often attended with danger, and need to be made with circumspection and care. The precautions to be taken are set out in some degree of detail. Of recent years Egypt has been particularly fruitful of instances of the kind, in which Mr. Lucas or his assistants would seem to have had ample scope for the exercise of their courage, skill, and ingenuity.

But the "tyranny of space" forbids any further attempt to illustrate the possibilities of chemistry as applied to the detection of crime. For other examples the reader may be referred to the book under review. The possibilities are, in fact, boundless. Mr. Lucas shows how the chemical examination of stains and marks, dust and dirt, even of tobacco, may afford clues which may lead to the conviction of criminals. Indeed, one rises from the perusal of his book with the feeling that the ideal forensic chemist would be a combination of Sherlock Holmes with a comprehensive compendium of general and analytical chemistry such as might be embodied in a person of whom fiction has hitherto afforded no example.

The "Index Kewensis."

Index Kewensis Plantarum Phanerogamarum. Supplementum Quintum Nomina et Synonyma Omnium Generum et Specierum ab Initio Anni MDCCCCXI usque ad finem Anni MDCCCCXV Nonnulla Etiam Antea Edita Complectens. Ductu et Consilio D. Prain, confecerunt Herbarii Horti Regii Botanici Kewensis Curatores. Pp. iii + 277. (Oxonii: e Prelo Clarendoniano, 1921.) 76*s*. net.

THERE is probably no publication which is awaited with such interest and impatience as the issue from time to time of the supplements of the "Index Kewensis." Had it not been for the interruption of the war, the list of genera and species published, or the publication of which was ascertained, in the five years 1911–15, would doubtless have been available to botanists less than six years after the second date. This delay was inevitable, but it may be assumed that Supplement 6, comprising the years 1916–20, is well on the way and will be available for workers before another five years have passed. Some names published abroad during 1914 and 1915 were not noted in time for insertion in the present supplement, but will be included in the next.

A rough estimate shows that the present volume indexes more than 33,000 species-names, and a perusal of a few columns indicates the large number and great variety of the books and periodicals which have been searched during the compilation of the work, which, so far as one can judge by inspection and trial, maintains the high standard of accuracy and completeness of the parts previously issued. It is a great help to have a note of the date of publication of the book or periodical cited; the absence of this was a disadvantage in the earlier volumes. Similarly the practice adopted in the previous supplement of not attempting to distinguish between species and synonyms, often a matter of personal opinion, has again been followed, and the work maintains its character purely of an index. Attention is directed in the preface to the fuller geographical citations as compared with previous volumes; thus in American species the name of the State follows the indication U.S.A.; in Chinese, the name of the province, and so on; this additional information is a distinct gain.

To the botanist a perusal of the columns is of special interest as marking the progress of botanical exploration generally; thus the large number of genera and species quoted as from China, especially the south-western provinces and the Philippine Islands, suggests the important work being carried on in those areas by British and American collectors and investigators. The progress of standard floristic works, such as the "Flora of Tropical Africa," or series of monographs, such as the "Pflanzenreich," is also recorded in these cases under the genera of families specially concerned.

The numerous entries under certain well-known European genera, such as Hieracium, which fills ten pages, and Rubus, which fills eight, recall the intensive study of species and their segregation, which will doubtless continue to supply material for future supplements. The many unwieldy trivial names, sometimes running into eight syllables, indicate the difficulty of finding new names for species when these run into the hundreds in individual genera. The occasional appearance of names from periodicals antedating the special period shows the great difficulty of sweeping up all the literature. Thus a harvest of new names has been supplied by Hegetschweiler's "Flora der Schweiz" (1839), previously overlooked, and the recognition of Philip Miller's "Abridged Dictionary of Gardening" (edition of 1754), in which many genera were carefully defined, necessitates the reference of some well-known genera to Miller instead of to later authorities.

In the method of citation the recommendation of the latest International Code of Rules is followed in the use of the capital letter only for species-names derived from a personal or a generic name. In the manner of production, from the irreproachable Latin preface onwards, the volume upholds the credit of the Oxford University Press.

Mental Measurement.

(1) *The Essentials of Mental Measurement.* By Dr. W. Brown and Prof. G. H. Thomson. (The Cambridge Psychological Library.) Pp. x+216. (Cambridge: At the University Press, 1921.) 21*s*. net.

(2) *How to Measure.* By Prof. G. M. Wilson and Prof. K. J. Hoke. Pp. vii+285. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1920.) 12*s*. net.

(1) ELEVEN years ago Dr. William Brown published as a thesis for his doctorate a suggestive and original monograph on the use of the theory of correlation in psychology. Later, by adding one or two chapters of introduction and two or three others on the so-called psychophysical methods, he expanded this monograph into a compact manual entitled "The Essentials of Mental Measurement." Now, in turn, after another and a longer interval, the manual itself has developed into a guinea royal-octavo volume, extensively enlarged and exhaustively revised.

The larger additions consist for the most part of a detailed series of mathematical arguments, examining what is termed the "hierarchical theory," and bringing

together the substance of important controversial papers on this subject published from time to time by Prof. Godfrey Thomson during the war. There are, however, several other new insertions. There is a long and lucid chapter on the elementary theory of probability and a shorter and more abstruse one upon skewness and heterogeneity in psychophysical data—a chapter in which, as indeed all through the volume, Prof. Karl Pearson's views and manner of approach are plainly reflected.

In the present stage of its development the book is an interesting though composite production. From the title one would expect some description of the recent methods of individual measurement—methods for assessing intelligence and for estimating the capacities and attainments of the mind. Instead we have critical prolegomena upon statistical adjuncts, and the writers have in view, not so much general mental testing, as the testing of the mental tests themselves. The book opens with a general chapter headed "Mental Measurement," which seems to promise the broad survey characteristic of a general text-book, but most of the pages in the second portion of the book, and most of the paragraphs in its two independent prefaces, are simply brilliant contributions to a special controversy. The three doctrines chiefly attacked are those connected with the name of Prof. Spearman. It is, however, highly satisfactory to learn that Dr. Brown finds elements of truth in the views that he disputes, and feels himself to be "more convinced than ever that the work of Prof. Spearman's correlational psychology is epoch-making in its significance."

The heterogeneous character of the volume has been severely criticised by at least one eminent statistician.[1] But perhaps the best defence to this criticism is the simple circumstance that at present the whole subject of mental measurement has itself arrived at a somewhat heterogeneous stage. In any case, the mixed and controversial quality of the book does not lighten or alleviate the difficulties of a topic already intrinsically perplexing. The treatment is of necessity technical. From first to last the pages of the book are dotted with algebraic formulæ and symbols, and the description of methods is at times extremely condensed. Indeed, to any but a mathematician little but the general gist of discussion can at times be comprehensible. However, a third section to the book is promised, summarising in non-mathematical language both theories and results for the general reader.

Meanwhile no research student who thinks of employing the statistical methods here described and discussed can ignore this treatise. It is, indeed, considering the intricacy of the subject, a work of great lucidity and compression, and, whether the criticisms urged against previous workers are insuperable or not, objections to their views certainly required statement at length and in detail.

(2) The volume by Prof. Wilson and Prof. Hoke is altogether different from that by Dr. Brown and Prof. Thomson. It is written for American teachers, and describes in simple phraseology some of the methods in vogue for individual measurement. The chapters consist mainly of an account of the various tests recently standardised for measuring attainments in the chief subjects of the school curriculum—reading, writing, drawing, arithmetic, and the like. A few pages are added on the measurement of intelligence and on statistical methods and terms. The book is published in the hope of encouraging the teachers themselves to apply to their classes the diagnostic methods that hitherto, for the most part, have been handled by psychologists alone. It is one of the many popular volumes that have appeared and are likely to appear upon the practical educational applications of these psychological methods.

Statistical Method.

A First Course in Statistics. By D. C. Jones. (Bell's Mathematical Series.) Pp. ix+286. (London: G. Bell and Sons, Ltd., 1921.) 15s. net.

THE needs of the student of social statistics form the prime consideration in this "First Course," but, as the author states, illustrations have been drawn from all sources, and it will serve very well as a brief introduction for students in other branches of science. The volume has been divided into two parts. Part I. is elementary in character, and in the main can be followed by a reader with little mathematical knowledge. The notions of measurement and of variables are explained, and the conceptions of the frequency distribution, of classification and tabulation are briefly discussed, and a couple of chapters follow on the simpler forms of average and the weighted mean. Dispersion comes next, accompanied by a more detailed discussion of the frequency distribution. The following chapter is on graphs, an unusual feature in this chapter being the inclusion of sections on interpolation and on supply and demand curves. A treatment of the correlation of two variables on simple lines concludes the first part of the book. Part II., though it begins simply, is of a more advanced mathematical character. The first few chapters are on probability, sampling, and probable errors. Prof. Pearson's generalised probability curves are then dealt with, and the method of moments; two chapters on the normal curve and the

[1] G. U. Yule, *Brit. Journ. Psych.*, vol. 12, pp. 100-107—an article which is itself of much importance as a contribution to the points at issue.

normal correlation surface conclude the volume. An appendix of some sixteen pages deals with a number of incidental points, and short notes are given on certain current sources of social statistics and on tables as aids to calculation.

The book seems very competently done, and we have noted few points for criticism that are worthy of individual comment.

A criticism of a general kind may, however, be made, namely, that the author has not kept in mind sufficiently carefully the type of reader whom he is addressing. The initial chapters of Part I. are written in a very simple style, adapted to a reader of little ability and practically no mathematical knowledge; but in the chapters on correlation differentiation is used, and in Part II., when Prof. Pearson's curves are explained, the reader will require a fair knowledge of and ability to use the calculus. The result is that parts of the book are beyond the elementary reader, and others almost too elementary in style for the more able student. It should, however, prove a useful addition to the small, but growing, number of books on the theory of statistics, for the same ground is not covered by any other volume. The printing and general get-up of the book are admirable, but author and editor of the series are to blame for not including an index.

G. U. Y.

Surveying for Oil Geologists.

(1) *Field Mapping for the Oil Geologist.* By C. A. Warner. Pp. x+145. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 13*s.* 6*d.* net.

(2) *Field Methods in Petroleum Geology.* By Dr. G. H. Cox, Prof. C. L. Dake, and Prof. G. A. Muilenburg. Pp. xiv+305+11 plates. (New York and London: McGraw-Hill Book Company, Inc., 1921.) 24*s.* net.

THE great increase in the demand for combined geological and topographic mapping of oil-fields has led to the issue of books to teach the rudiments of geology to surveyors and of surveying to the geologist. These two manuals belong to this group. (1) The smaller, by Warner, is written with special reference to the conditions of the central oilfields of the United States, and it includes tabular summaries of their geological sections. The geology is otherwise so elementary that no oil company would be well advised to trust to geological surveys by men whose knowledge of the subject is so limited that they would gain any help from the chapters thereon in this book. Its concise mathematical tables, simple explanations of surveying methods, instructions for the preparation of convergence maps and for the verification of oil scums on seepages, may, however, render it useful to geologists who have had no special training in oil prospecting and may be called on to take part in this work.

(2) The work by Messrs. Cox, Dake, and Muilenburg, three professors of the Missouri School of Mining and Metallurgy, is a larger work, and its geology is more advanced. The mathematical tables are fuller, and the account of geological structures may be read with great advantage by students of geology in schools which do not give much attention to the structural side of the subject. It has an admirable glossary, which explains among other facts that the term "wild-cat" in oil mining is not the same term of contempt as in metal mining, as it is applied to all well-sinking in unproved territory. This development of the term suggests that American opinion regards all oil boring in unproved ground as so speculative that the expression is used for it which the metal miner adopted for forlorn hopes and reckless gambling. In a book in which conciseness is so indispensable it seems unnecessary to have included the history of the mariner's compass and of the barometer.

Neither book gives any help in the use of fossils. The Missouri manual refers to fossils as if their evidence were too difficult for use by any but an expert; considering, however, the importance of fossils in oil work and the value of the indications often given by the simplest of palæontological evidence, some instructions how to recognise and collect fossils might usefully have been included.

The Fourth Dimension.

The Fourth Dimension Simply Explained. A Collection of Essays selected from those submitted in *The Scientific American's* Competition. Pp. 251. (London: Methuen & Co., Ltd., 1921.) 7*s.* 6*d.* net.

THE fourth dimension and non-Euclidean geometry have achieved a prominence quite unprecedented for mathematical topics. In train, bus and tram, over lunch and at the theatre, intelligent man is discussing the fundamentals of his physical consciousness. Mathematicians have sprung a surprise on the man in the street—and on one another, and the former has some reason to complain. He remembers, perhaps with pain, the tyrannical ukases of Euclid, and, if he did not acquire an enthusiastic love for the old Greek, he was at any rate pleased to think that the puzzles of geometry had been settled by something approximating to incontrovertible authority; he was grateful that he need not worry about the doctrine of parallels, or the three angles of a triangle, or about the up and

down, to and fro, right and left. Suddenly the man in the street finds himself floundering in a morass of sceptical ignorance.

How much good it would have done him if it had been impressed upon him early enough that geometry "is a matter of experiment and of experience," that it "shows what would be true if certain other things were true," if he had realised that Euclid was a guide in the interpretation of ordinary space experience, and not a royal promulgator of irrevocable decrees! He would have been spared some of the journalistic sensationalism of the past two years, and have been better equipped to think clearly and without prejudice.

Of course the fourth dimension of relativity is not the same as that suggested by the older conception of four-dimensions, although it is still a common experience to hear somebody complain that it is nonsense to suggest that time is $\sqrt{-1}$ times a length. Nevertheless this book of essays will be read with interest. The book was worth publishing if only for the clear and excellent introduction by Prof. Manning.

Some of the essays are distinctly good, although they all suffer the inevitable consequence of having a lot of information crammed into a small space. Several are impartial, others seem to look with favour on the possibility of a fourth dimension, while a few speak of it with scant respect. There is very much repetition, as is bound to be the case in such a publication, and a considerable amount of the sort of speculation that finds indications of the fourth dimension in spiritualistic phenomena, that makes the fourth dimension a constituent of life-force, that sees the fourth dimension suggested in Ephesians iii. 18, and that thinks it possible that many of the small objects each of us loses disappear by rolling out of three-dimensional space into the fourth dimension! S. Brodetsky.

Our Bookshelf.

Imperial Institute: Monographs on Mineral Resources with Special Reference to the British Empire: Petroleum. Prepared jointly with H.M. Petroleum Department with the co-operation of Dr. H. B. Cronshaw. Pp. x+110. (London: John Murray, 1921.) 5*s.* net.

A new "red" book dealing with petroleum has appeared recently as a small volume uniform with the well-known monographs of the Imperial Institute. It is a type of publication that was much needed, since it embodies in summary form the main geographical, geological and economic features of the world's oil-fields. At the present time this information is very scattered, more particularly in connection with British resources, so that a scientific discussion of the subject, at once lucid and easily accessible, forms a welcome addition to official technical literature.

The volume is divided into three sections, the first reviewing briefly the more theoretical phases of oil technology, such as the origin, migration, and accumulation of petroleum, the second dealing with British, Colonial, and mandatory resources, and the third with foreign resources. Several statistical tables concerning production of oil in various countries are included, the information under this heading being brought up to 1920 in most cases; the results of distillation of typical crude oils are given, together with certain physical characteristics. A small map of the world showing the principal oil-bearing localities and a short bibliography are appended.

A somewhat unfortunate attempt has been made to tabulate the characteristics of the oil regions of the United States, a task requiring no little care and a great deal more space than has been allocated to it; one would scarcely describe the prevalent structure of the Appalachian region as anticlinal, while the omissions in the same connection under the headings of Lima–Indiana and the Rocky Mountains are difficult to understand. With this exception, the text is remarkably good in every way. H. B. Milner.

Peoples of All Nations. Edited by J. A. Hammerton. No. 1. Pp. xxiv+112. (London: The Amalgamated Press, Ltd., 1922.) 1*s.* 3*d.* net.

This is the first instalment of a popular work to be issued in fortnightly parts which, when complete, will give an account of all the nations of the world in alphabetical order. It is a remarkable piece of journalistic enterprise. The whole work promises to be of great interest and of some considerable educational value as a work of reference for the class of reader for whom it is intended. In the present number Sir Arthur Keith contributes a foreword on the "Dawn of National Life," which deals with racial origins and the development of culture. The nations described are Abyssinia, Afghanistan, written partly by Sir Thomas Holdich, Albania, in part by Miss Durham, and Algeria. Each article is divided into three parts, of which the first deals with geography and ethnology, the second is historical, each of these being by a recognised authority, and the third gives statistical and other data. In view of the limited amount of space available, the articles are extremely well done and give the salient facts in readable and attractive form. The chief feature of the publication, however, is the illustrations, which are remarkable both in number and quality.

Tables, Factors and Formulas for Computing Respiratory Exchange and Biological Transformations of Energy. By T. M. Carpenter. (Publication No. 303.) (Washington: Carnegie Institution.) 2 dollars.

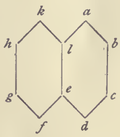
Publication No. 303 of the Carnegie Institution contains not only a number of tables for the expression of the results of gas analyses but also those of Benedict and his colleagues and of Aub and Du Bois for the estimation of basal metabolism. Some of these tables are inaccessible and all are scattered through a variety of journals and monographs, so it is a great convenience to the investigator to have the whole series in a single handy volume. This work will take its place beside "Chambers," "Barlow," and "Tables for Statisticians and Biometricians," on the shelves of most workers.

Letters to the Editor.

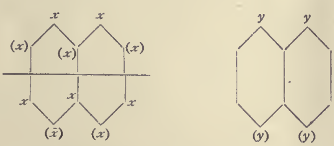
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Atomic Vibrations in the Molecules of Benzenoid Substances.

SIR WILLIAM BRAGG has recently suggested (Presidential Address to the Physical Society, Proc. Phys. Soc., 1921, 34, 33) that in the molecule of crystallised naphthalene the carbon atoms are arranged so that in the accompanying figure the centres of atoms at h, l, b, g, e, c lie in a plane, whilst those at k and a lie above the plane and those at f and d an equal distance below it.



If this were the normal stable arrangement in naphthalene and its simple derivatives, enantiomorphism would result in the case of all monosubstituted, and in the majority of the higher substituted compounds, the special examples of symmetry being obvious on inspection. Since, however, all the available evidence tends to show that the molecules of naphthalene derivatives are identical with their mirror images, it follows that the structure suggested by Sir William Bragg represents a phase of an oscillation of the relatively unrestricted molecules of the fused or dissolved substance in which the pairs of carbon atoms k, a and f, d appear alternately above and below the plane containing the six remaining atoms. At the first glance such a process appears peculiar and unsymmetrical, but this objection disappears when it is noticed that an identical result is obtained if all the atoms are supposed to be in motion in such a way that adjacent atoms move in opposite directions and to an equal distance from the plane of the original ring. If the component perpendicular to the plane of the ring is x, then the condition arrived at is shown below, x and (x) signifying, respectively, above and below the plane of the ring.



By rotating about the axis figured, the second position is obtained with six atoms in the plane of the original ring and four arranged as indicated ($y>x$ and $<2x$). A similar vibration of the phenanthrene molecule would demand in the case of an isolated phase that the atoms lie in two planes parallel with that of the original ring, and also in four parallel planes containing carbon atoms to the number of two, six, five, and one, respectively. The above argument is circular to the extent that the naphthalene configuration was partly derived by analogy with the hexagonal rings of the graphite layers, but the point is that if independent evidence is forthcoming that an individual naphthalene molecule in a crystal has the arrangement of atoms put forward by Sir William Bragg, then at the same time at least one mode of vibration of the benzenoid molecules will be clearly indicated.

R. ROBINSON.
Chemistry Department, The University, St. Andrews.

Transport of Organic Substances in Plants.

IN a letter in NATURE of February 23, p. 236, under the above title, Prof. H. H. Dixon and Mr. N. G. Ball put forward the view that the wood of the vascular bundles provides the main path for the removal of the organic materials formed in foliage leaves to places of storage or conversion, the structure, form, and arrangement of the bast (phloem) being regarded as precluding any important longitudinal transmission within it.

I venture to doubt if the view that the phloem may serve as an important carbohydrate-conducting tissue merits such summary dismissal as the writers of the letter would appear to suggest.

In the first place, it is somewhat misleading to state that this belief . . . "seems to be based entirely on ringing experiments," unless this statement is intended to apply only to the "older writers." In an article on the Translocation of Carbohydrates (*Science Progress*, October 1910, January 1911) I attempted to bring together the available evidence from anatomical and experimental studies, and a perusal of that paper should show the wider basis for the view put forward by Czapek in 1897 that the phloem is to be regarded as the chief tissue concerned in the conduction of organic material in the plant. In later papers (*Annals of Botany*, 1915, 1917) I dealt with many of the points which call for consideration in any investigation of this problem, and indicated the nature of results obtained by the application of Senft's method of locating sugars by the formation of their osazones. Unfortunately, the war and the heavy pressure of departmental duties have held up the work, and it has not yet been possible to publish results in detail.

The following comments may be made, however, in connection with the view put forward by Prof. Dixon and his collaborator. The sugars are described as having to traverse the cross-partitions (of phloem cells) as a stream if they use this tissue as a conduit. It may be doubted whether the movement can be compared to the mass movement of water in a tube, and other considerations have been urged in the later paper referred to above.

Experiments made by Czapek (referred to in my last paper, pp. 293, 294, 303) showed that removal of starch from an attached leaf continued if a short length of the petiole was plasmolysed (but not killed), that a killed (boiled) portion of petiole prevented translocation permanently, but that a narcotised portion only temporarily interrupted the process, which was renewed on recovery of the tissues. Though perhaps not altogether excluding the possibility of conduction in the wood, such experiments appear to point to the activity of living cells in the transportation, and I have suggested a possible explanation of the continuance of the process in plasmolysed (living) cells, assuming the sieve-tubes to be the channels concerned (*loc. cit.*, p. 303).

Various histological features of sieve-tubes and their associated cells appear to harmonise well with the view that they serve to conduct carbohydrates, *e.g.* their continuity, distribution, and degree of development in different types of plants, the structure of the sieve-plate, the distribution of connecting-

threads, the relation of sieve-tubes in the parasite Cuscuta to those of its host, etc.

A particularly interesting piece of evidence in favour of the phloem view is to be found in a paper by Schneider-Orelli on a leaf miner of the apple (*Centralb. f. Bakt.*, 11 Abt., 1909, 24, p. 158; cited by Schroeder, *Zeitschr. f. Bot.*, 1911, pp. 770-71). Where the caterpillar had bored through strong veins the destruction of the tissue affected the storage of starch in the leaf. It was found that the destruction of the xylem and the greater part of the bundle sheath could be brought about without causing an accumulation of starch in the distal part of the leaf (by interrupting the conducting channels), but that injury to the phloem resulted in an accumulation of starch proportional to the extent of the injury. Similarly, it has been found by Quanjer and others that the phloem necrosis associated with the leaf-curl of potatoes interferes with the transport of starch from the leaf, with the result that the tubers fail to develop properly.

It may also be noted that in a paper on the biology of a species of Aphis, Davidson (*Annals of Applied Biology*, v. 1921, p. 60) states that the phloem of the vascular bundles is especially sought for by these insects when tapping the plant for nutriment, and that this point is undergoing further investigation.

Although the case of Lepidodendron undoubtedly presents difficulties (a possible solution was suggested by me, *loc. cit.*, pp. 307-9), the difficulties are scarcely less on Prof. Dixon's view in the case of various aquatic plants which normally produce no xylem or only discontinuous traces.

I look forward with very great interest to the results of the work which Prof. Dixon and Mr. Ball have in hand, as the problem is a long-standing one. An urgent need is for more data on which to elaborate a theory of translocation in general.

SYDNEY MANGHAM.

Botanical Department, University College,
Southampton, March 28.

Pricked Letters and Ultimate Ratios.

IT is the purpose of this note to point out an earlier use of "pricked letters" to denote infinitesimals and of the phrase "prime and ultimate ratios" than is recorded in our histories of mathematics.

It will be recalled to mind that as early as 1665 Isaac Newton used "pricked letters" to denote fluxions or velocities. He did not permit his notation to appear in print before 1693. Between 1693 and 1704 the dot came to be used by other English writers, but nearly all of them departed from Newton in interpreting $\dot{x}$ to mean, not a velocity, but an infinitely small quantity or increment, like the Leibnizian *dx*.

Recently the present writer has noticed that as early as 1668 Nicholas Mercator used the dot to mark an infinitesimal, in an article in the Philosophical Transactions,[1] which contains illustrations of his "Logarithmotechnia" of 1668. Mercator uses in his article the letter I with a dot over it to indicate an infinitesimal difference.[2] This date, 1668, marks the earliest use of the dot for this purpose known to us. It was long before Newton allowed any part of his fluxions to appear in print and before Leibniz began to develop his calculus. Mercator could not have regarded the dot simply as part of the letter I, for (though the type is not quite clear) it appears to have been the capital letter. Moreover, in computing logarithms he writes the dot over a number ($\dot{64}$, for example), to serve as a reminder that 64 is the coefficient of a power of an infinitesimal.

In the same article Mercator used a terminology[3] resembling the famous phrase "prime and ultimate ratios," used by Newton in his "Principia," 1687 (Bk. i. Sec. i. Lem. xi., Scholium). Mercator writes "ratiunculae" or little ratios, while Newton uses "rationes" or ratios. Mercator says "primae et ultimae ratiuncularum," Newton speaks of "rationes primae," and "rationes ultimae." We observe also that in 1695 Edmund Halley (Phil. Trans.) used "ratiuncula," and that in 1706 William Jones ("Synopsis Palmariorum," p. 174) made the statement: "Let $\dot{x}$ be a Ratiuncula or Fluxion of the ratio 1 to 1 + x."

It appears on the surface as if there had been a giving and receiving. In his letter to Oldenburg, dated October 24, 1676, Newton mentions Mercator's "Logarithmotechnia," but he nowhere refers to Mercator's illustrative article from which we have quoted. That article is of minor importance. It is not reproduced in the abridged edition of the Philosophical Transactions, and is not mentioned in the biographical sketches of Nicholas Mercator that we have seen. Whether in private Newton had used the phrases "prime ratios" and "ultimate ratios" on or before 1668 we have no means of knowing. He first used them in print in 1687. For some years after 1660 Mercator lived in London, where he became a member of the Royal Society. Newton became a member in 1672. As Newton lived at Cambridge (except during the Plague, when he was in the country), the chances that Mercator received information of Newton's work through private channels are reduced. After 1669 both Mercator's "Logarithmotechnia" and his illustrative article were in print. It is therefore possible that Newton may have adopted the phrase "prime and ultimate ratios" from Mercator. Newton's dot-symbol antedates Mercator's.

FLORIAN CAJORI.

University of California, March 18.

[1] Phil. Trans., London, vol. 3, p. 759 ff. Reprinted in Maseres, *Scriptores Logarithmici*, vol. 1, p. 231.

[2] The passage in question relates to the use of the infinite series for finding log ($1 \pm \dot{I}$) and is as follows: "Quare posito maximo termino = 1, et parte infinitissima (sic) differentiae = I, et mensura rationis minimae itidem $\dot{I}$." He gives proportions like the following:

$$\text{“}1 - \dot{I} \,.\, 1 :: \dot{I} \,.\, \dot{I} + \dot{I}\dot{I} + \dot{I}^3 + \dot{I}^4, \text{ etc.”}$$

Here the fourth term of the proportion is an infinite series; ratio is indicated by (.) placed at the lower edge of the line.

[3] The passage in Mercator is, " . . . non nisi semisse primae et ultimae ratiuncularum a prioribus terminis contentarum, id est, ratiuncula minori, quam quae ullis numeris exprimi possit."

Einstein's Aberration Experiment.

IN the *Sitzungsberichte* of the Berlin Academy of December 8 last, which has recently come to hand,

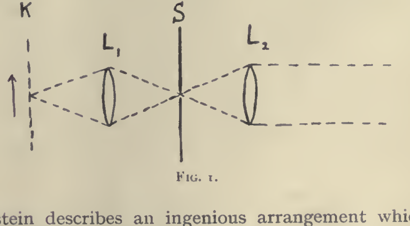


FIG. 1.

Einstein describes an ingenious arrangement which he suggests might serve to decide between the

classical theory of light and the theory in which light is regarded as made up of single quanta of energy emitted discontinuously from luminous atoms. Fig. 1 (reproduced from the paper) illustrates the proposed experiment. K is a stream of canal rays, L_1 is a focussing lens, S is a screen containing a slit which serves to isolate a definite pencil of light, and the lens L_2 renders the emergent beam parallel. The emergent pencil is observed through a telescope focussed for infinity, so that the image of the slit in the screen S would be seen sharply focussed in the field of view. Since the atoms in the canal rays emitting light are in motion, the Doppler effect comes into evidence, and the rays proceeding at any instant from individual luminous atoms in different directions should, according to the wave-theory of light, be of different frequencies. Einstein suggests that the rays passing through the slit S and incident on the upper and lower parts of the lens L_2 should consequently be of different frequencies. If, therefore, a layer of a dispersing medium such as carbon disulphide be placed between the lens L_2 and the observing telescope, the different rays would travel through it with different velocities. Hence the wave-front should suffer an aberration and the image of the slit seen in the focal plane should shift through an extent proportionate to the thickness of the dispersing layer introduced. Einstein conceives that according to the quantum theory of light, on the other hand, such displacement should not occur, and he believes that the proposed arrangement furnishes an *experimentum crucis* to decide between the rival theories.

I wish here to direct attention to a fallacy which is present in Einstein's reasoning and invalidates it. It is clear that in the proposed experiment what would be observed are not the moving luminous atoms but the fixed edges of the illuminated slit in S, and it is easily shown that even according to the principles of the wave-theory no aberration of the image of the latter could be expected. To make this evident we may conceive the slit to be extremely narrow, or in the alternative, if it be wide, regard it as divided up into a large number of very narrow elements each of which, according to Huyghens's principle, would operate as a secondary source of light. The light from any small portion of the lens L_1 arriving at the slit would spread out by diffraction in all directions in the form of cylindrical waves, so that the waves reaching L_2 would consist everywhere of *superposed* wave-fronts of all the frequencies reaching the slit, and not, as Einstein supposes, of different frequencies at different points of L_2. The waves diverging from S would thus pass through L_2 and the dispersing medium behind it according to the ordinary laws of geometrical optics, and no shift or aberration of the image of the slit would occur. The error in Einstein's reasoning lies in his having ignored the vitally important part which diffraction plays, according to the wave-theory of light, in the theory of the formation of images of illuminated apertures by optical instruments.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta, March 16, 1922.

The Weathering of Mortar.

MR. RICHARDSON's letter (March 9, p. 310) anent the above calls, I think, for some further remarks. My observations never led me to conclude that the growth of moss was in any way responsible for the development of the ridge-and-ring markings upon the surfaces of old and exposed mortar. I have seldom seen moss growing thereon, but lichen is very often present, covering the whole surface, and not limited to the linear concavities. There is a row of fishermen's cottages at St. Ives, Cornwall, fully exposed to the sea, and the old mortar in the walls shows the markings in unusual perfection, but there is no evidence that moss ever grew upon it.

In 1896 I suggested that the phenomenon was a physical effect due to the expansion and contraction—or perhaps the former only—set up by alternations of temperature in a substance like mortar. Strains and stresses along lines of least resistance would tend to destroy compaction along such lines, rendering them more liable to be deepened by atmospheric erosion. Possibly the expansion and contraction in the stones themselves may also affect the stability of the mortar.

FIG. 1.

The accompanying photograph (Fig. 1), taken many years ago, shows some ridge-and-ringed mortar at the base of an old wall near Corfe. The wall faced south, and was built of Purbeck limestone. During its construction some thin pieces were placed vertically between the two masses of mortar. The penny fixes the dimensions of the mural components. The structure here was very conspicuous, but, with lapse of time, the photograph has faded somewhat.

C. CARUS-WILSON.

March 17, 1922.

Metchnikoff (Mečnikov) and Russian Science in 1883.

I HAVE read with the greatest interest the review of the "Life of Elie Metchnikoff" published in NATURE of February 9. In NATURE of November 17, 1921, I gave an account of the present state of science in Russia and its "proletarisation," and I beg to be permitted to say a few words on the state of science under Russian absolutism.

According to the above review, the book referred to says that the government of the university of Odessa became more and more reactionary; but it was not for political reasons that Metchnikoff left the university—the reasons were "scientific."

Following an invitation, I took part in the Congress

of Naturalists which was held in Odessa in August 1883, and of which I am the only foreign survivor. I became acquainted with the most prominent professors of that University and found that they were first-rate men of science, without a trace of anything "backward and reactionary." And yet this reproach is correct, but it refers to the State director of the university. A man, unsympathetic, gloomy, reactionary, every inch a bureaucrat, and fairly old, inaugurated the first general meeting with the following severe words: "You came here to speak of science and I hope that you will speak *only* of science!" After this rose Metchnikoff and gave a brilliant account of his recent and unpublished work on phagocytosis, which was received with enthusiastic applause by the whole assembly.

I congratulated my Russian colleagues and the University upon having such a professor, but they replied with regret that he no longer belonged to the University, and upon asking for reasons I was given the explanation: Metchnikoff as a professor of zoology announced a course of lectures "On the Theory of Evolution." And now the very reverse took place of what I described four months ago (see above). The director summoned Metchnikoff to his office and said to him: "It appears that you are going to lecture on Darwinism? If it is so, then you must submit your written lectures to my censorship and I will tell you what I allow you to say to the students and what not!" Metchnikoff did not accept this explanation of the "Lehr- und Lernfreiheit," he did not submit his notes to the curator; he resigned the professorship. Russia was not the soil for such a genius, and it was good fortune for him and for science that he left for Paris and for Pasteur.

Bohuslav Brauner.

Bohemian University, Prague, March 9.

The Accuracy of Tide-predicting Machines.

Under the above title in Nature of February 23, Dr. A. T. Doodson comments on my letter that appeared in the issue of Nature for February 2 under the same title. Unfortunately, Dr. Doodson is dealing with a matter outside the scope of my letter, and his statement that he is not "convinced by the tests recorded by Mr. Marmer" in no way invalidates any of the statements in my letter.

As specifically stated in my letter, it was prompted by a desire to prevent the possible misconstruction, on the part of *those not familiar with tide-predicting machines*, of a statement to the effect that tide-predicting machines are subject to "serious errors in their results." Occasion was also taken to direct attention to the different types of tide predictors and to a table showing the differences between computed and predicted heights for one day in the case of Hong Kong.

With none of the statements relative to these matters does Dr. Doodson appear to be in disagreement. What he does question, however, is something outside the scope of my letter, namely, whether the tide predictor with the operation of which I am familiar is or is not suitable for predicting hourly heights for *research purposes* within 0·05 ft. for a spring range of 30 ft. Not being concerned with that question at the time, there appeared no occasion for the tests, "exhaustive and convincing," that Dr. Doodson desires.

In his letter Dr. Doodson states that the tide predictors at his command were found unsuitable for use in the elimination from the observed tide of the tide due to a number of constituents. Nevertheless, this does not invalidate the general proposition that in such problems "the tide predictor should very materially lessen the laborious computations involved."

H. A. Marmer.

U.S. Coast and Geodetic Survey, Washington, D.C., March 18.

It seemed to me that Mr. Marmer's first letter left the impression that the U.S.A. machine is one that is free from serious errors of the order of magnitude of those of the British machines, and I raised the question of proof. I said that I should be very glad to know that this machine could produce hourly heights to within 0·05 ft. with a spring range of 30 ft. I *questioned* whether it would or would not give errors of 0·4 ft. in such a case. If my doubts are warranted, then the U.S.A. machine also is subject to serious errors, which, as I suggested, would prohibit its use for the research work mentioned above in Mr. Marmer's last paragraph.

A. T. Doodson.

Tidal Institute, University of Liverpool, April 3, 1922.

Pythagoras's Theorem as a Repeating Pattern.

It may not be generally known that the Theorem of Pythagoras, Euclid I. 47, is closely connected with the Theory of Repeating Patterns in space of two dimensions. The simplest proof by dissection of that Theorem establishes at once that any two squares placed in contact as in the accompanying diagrams (Fig. 1) constitute a figure such that a number of them can be assembled so as completely to fill flat space.

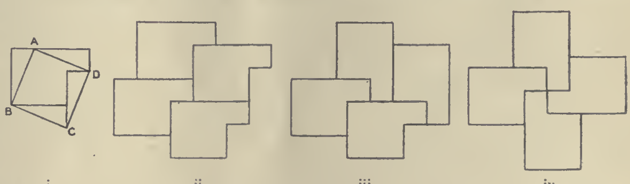


Fig. 1.

Fig. 1 (i.) shows the proof by dissection. Also the large square, regarded as a base, shows by the Principle of Transformation in the Theory of Repeating Patterns that the figure formed of the two squares is a repeating pattern. The transformation consists of cutting out the triangles the bases of which are BC and CD and erecting them upon the sides BA, AD. This nature of transformation yields an infinite number of repeating patterns of a particularly interesting kind, because of this category each member has the property that the assemblages can be carried out in three different ways, namely, so as to exhibit 1, 2, or 4 orientations or aspects of repeat respectively. In the present case of the Pythagorean Repeat the three ways of assembling are shown in Fig. 1 (ii., iii., and iv.).

Percy A. MacMahon.

27 Evelyn Mansions, Carlisle Place, S.W.1.

The Age of the Earth.[1]

By Prof. J. Joly, F.R.S.

"THE Age of the Earth" is a somewhat ambiguous phrase. From the geological point of view it is generally understood to mean the age of the ocean: in other words the age of the earth since the beginning of those geological surface changes which are due to denudation. But another meaning may be ascribed to the term. We may assume the beginning to date from the cooling of a highly heated surface to the point of solidification. In this case we include in the age those long periods of Archæan time during which the activity of water played a subordinate part and volcanic commotion prevailed among the semi-fluid, rocky constituents of the globe. Yet a third interpretation refers the birth time to a still more remote and indefinite epoch when the world became differentiated as a planet by activities, of the nature of which we are ignorant. Astronomical deductions and speculations regarding the Age are mainly concerned with the last period.

What I have to say will be restricted, almost entirely, to the first interpretation of the term. I mean by the age of the earth the period which has elapsed since its surface became the scene of world-wide denudative forces and the foundations of organic evolution were laid.

In virtue of these denudative forces we find ourselves possessed of certain methods of estimating the Age which are valid upon the assumption that denudation proceeds in our time at a rate not greatly differing from its mean rate over geological time.

The bases of this assumption are as follows:—

(*a*) That the chief factor in denudative activity being the rain supply falling on the land, solar heat and atmospheric circulation are primary causes. The life on the globe since very early times and the narrow temperature limits conditioning protoplasmic existence and activity show that great extremes of solar radiation cannot have affected denudation for long periods in the past. Mere climatal extremes do not sensibly affect solvent denudation. Atmospheric circulation, being largely conditioned by the earth's rotation and the distribution of solar heat, cannot have varied to any effective extent.

(*b*) That a considerable percentage of the existing land area being rainless, changes in continental area cannot greatly affect the amount of denudation: the belt undergoing denudation being merely displaced outwards or inwards. The evidence derived from palæography and from the extent of sedimentary deposits in all ages shows that the present land area is not greatly different from the past mean area.

c) That the minor factors affecting solvent and detrital denudation being very many and of very different character are unlikely to combine at any time, and for any long period, in one direction, so as to create a considerable departure from the mean.

Time will not permit a discussion of these statements. I shall refer but briefly to the methods by which the statistics of solvent and detrital denudation are used to afford the age of the ocean.

(1) The chemistry of the ocean and of the rocks is the key to our position. As the result of a comparative study of the primary or igneous rocks and the secondary or sedimentary rocks we find that, say, n grams of sodium are shed into the ocean for each tonne of igneous rock converted into sedimentary rock, and in the ocean we find N grams of sodium. The total denudation over geological time has, therefore, been N/n expressed in tonnes of denuded igneous rock. Our study also tells us the average total loss attending the conversion of the primary rock into sediment, and so we get the total of the secondary rocks in tonnes. We now go to the principal rivers of the world and availing ourselves of estimates which have been made of the amounts of sediment—*i.e.* of secondary rock material—which they transport from the land in a year, we calculate the number of years which it would take to lay down in the ocean the great mass of sediment generated in the past ages. After certain allowances this comes out as about 100 million years.

(2) Again the total of oceanic sodium may give us the Age in another and more direct way. We know that by far the greater part of this sodium was carried into it by the rivers during geological time. We turn to the analyses of river water and estimate the total annual supply of this element to the ocean. Dividing the latter into the former and making certain allowances we find an Age which is about 100 million years.

(3) A third and more difficult method is independent of our knowledge of chemical denudation. We estimate the maximum thickness of the integral sedimentary deposits, and knowing the burthen of sediment conveyed per annum by the rivers, we estimate the maximum thickness of deposit annually derived from the same; we divide the latter into the former and find an age which, again, is about 100 million years.

Of these methods, that which involves the sodium modulus only is the most direct. Of course the reason for selecting this particular element as a modulus is because of its great solubility, on account of which it alone among the dissolved oceanic constituents has been preserved from organic abstraction or chemical precipitation. This method has been examined by many critics. Notably by Sollas, who, in a presidential address to the Geological Society in 1909, subjects it to searching examination. He concludes that a period of 175 millions of years may be reached upon certain assumptions, and that this must be very nearly the maximum allowable. My own examination of this method has led me to believe that it is *possible* that 150 millions of years may be indicated by it, and that 200 millions of years would not be reconcilable with our present knowledge of the factors involved. This would, as I have already stated, apply only to the duration of sedimentation. It cannot be compared with data which apply to an age dating back into the Archæan.

[1] Discourse delivered at the Royal Institution on Friday, February 24.

There was, indeed, some scanty sedimentation in Archæan times. We cannot form any estimate of its effects either upon our numerator or upon our denominator save that we seem entitled to conclude that they were small. "The Archæan was essentially a period of world-wide vulcanism, and in the relative proportions of rocks of igneous and sedimentary origin represents a departure from the uniformity of conditions of later geological time." I quote from the monograph of Van Hise and Leith.

Before passing on to the results based upon radioactivity I must refer to one point in particular which has been urged against accepting present-day rates of denudation as a basis of time measurement. It is said we live in a period of abnormal continental elevation which, it is asserted, involves excessive solvent denudation. A little attention to the nature and conditions of solvent denudation should have sufficed to forestall the argument. But a ready method of dealing with it is available. The continent of North America has a mean elevation of 700 metres: it is being denuded at the rate of 79 tonnes per square mile per annum: for South America the corresponding figures are 650 metres and 50 tonnes. Now Europe has a much lower mean elevation—300 metres. Its rate of denudation is, however, 100 tons per square mile per annum. The rate of solvent denudation is, in fact, by measurement found to be *less* for the more elevated land, as, theoretically, it should be. The argument then, if it has any basis, would indicate that the age as found from solvent denudation is excessive.

Prior to the advent of those methods for investigating the earth's age, which are based on radio-active changes in the elements, no serious objections to the results reached by the geological methods were raised, so far as I know. There were some, indeed, who regarded the age as excessive. Thus Becker arrived at a lesser figure by taking into account the progressive impoverishment of the surface materials during geological time. The validity of the correction is, however, open to doubt. Others considered that the organic changes recorded in the rocks required a longer period. Sollas gave, as I think, a clear answer to this objection in his "Age of the Earth." Both Lyell and Geikie, and Poulton, had in past years upheld the doctrine of Uniformity. But the advent of the radio-active method, as founded on the uranium family of elements, seemed to point to a vastly greater Age; leading, in fact, to the extraordinary conclusion that the present rate of solvent denudation is not less than four times and may be eight (or even more) times in excess of the average rate obtaining during the past.

The earliest suggestion of the possibility of using the stored-up products of radio-active change came from Rutherford. He, and later Strutt (now Lord Rayleigh), applied the accumulation of helium to the evaluation of geological time. Strutt laid out a geological chronology, the first of its kind, but considered he was dealing with minor limits. Boltwood used the residual product of uranium—lead—and for Archæan (?) materials reached as much as 1640 million years. As I have already said, the denudative method cannot be regarded as extending to those remote times. But such results as 430×10^6 years for Silurian or Ordovician deposits, and 1200×10^6 years for Post-Jatulian are quite out of harmony with the denudative method. To-day the matter stands thus:—A number of results are available based upon the use of carefully selected material, and when the material is thus selected the ratio of lead to uranium —the "lead ratio" as it is termed—increases as we go downwards and diminishes as we go upwards in the strata, preserving a fair degree of agreement even for widely separated localities.

Those who would rest content with this result, however, can do so only by ignoring the very interesting and suggestive fact that when we base the results on the lead ratio of selected thorium minerals, we arrive at ages which are in substantial agreement with the results reached by the denudative method. On the face of it this agreement gives strong support to the conclusions reached by methods absolutely different in nature.

For long it was known that thorium minerals—such as thorite—gave persistently lower ages than uranium minerals. It became the custom with some to treat these ages as untrustworthy. But we know now that this attitude is not justified, but rather that the onus of explaining away the impressive agreement between the indications of thorium lead and denudative statistics rests with those who would reject the Age supported by both.

Soddy's determination of the atomic weight of the thorium lead isotope, in 1917, afforded material for an age determination on a very large scale, and from the nature of the research, one of special value. The material was a thorite from Ceylon; from rocks immediately overlying the Charnockite series. The latter is extremely ancient—Lewisian or Lower Archæan. Upon reading in Nature Prof. Soddy's account of his determination of the atomic weight of the lead derived from these rocks, I estimated that the quantity of lead extracted from the thorite gave an age of 130 millions of years for the time since this mineral had been generated; and on communicating with Prof. Soddy I found that he had reached a somewhat similar conclusion.

At this time, however, there was the possibility that thorium lead was not altogether stable. Suspicion fell more especially on thallium as the final product. Two experimental results, however, laid this doubt to rest: experiments upon a thorianite made in my laboratory by J. R. Cotter failed to detect even spectroscopic traces of this element, and there was insufficient thallium found in the thorite dealt with by Prof. Soddy. In a subsequent letter to Nature Prof. Soddy states that a research carried out at the Radium Institute of Vienna supported the view that the lead isotopes derived from thorium were both stable. I shall refer presently to yet additional evidence that the transformations of the thorium family cease with lead.

Writing to Nature in support of the hypothesis then under discussion—*i.e.* that thorium lead was unstable—A. Holmes cited a result on a selected specimen of uraninite, showing that the rocks in which Soddy's thorite occurred were, according to the uranium-lead ratio, 512 millions of years old. Previous uranium-lead ratios had assigned a much greater age

to them. Here, then, the results join issue: the uranium result is just four times as great as the thorium. We notice, too, that on the uranium-scale of time this thorite must be older than Silurian or Ordovician, which have been determined by uranium lead as 430 millions of years ago. Probably its age dates back to Cambrian or even to pre-Cambrian time. From what we have already inferred we cannot regard 130 millions of years for early Palæozoic time as irreconcilable with the maxima which denudative methods afford. More recently, lead derived from a Norwegian thorite of Langesundfiord—also of lower Palæozoic age—seems to reveal an age of 150 millions of years. In this case, also, there is the added security of a determination of the atomic weight of the lead.

We cannot discredit these results on the score of radio-active instability of the lead. Why, then, set them aside in favour of results reached on uranium lead, which are in hopeless contradiction with the indications of the record of the surface activities of the globe? It is, indeed, not too much to say that the whole position is now reversed and that to-day suspicion attaches to the uranium-lead ratio. And, as we shall see, there is much unknown about the earlier radio-active sequence in the uranium series; while the discovery of isotopes opens the way to possibilities unthought of in the earlier days of radio-active science.

I shall, however, now turn to the evidence of the pleochroic halo on this matter.

The halo affords a means of investigating certain facts respecting the break-up of the radio-active elements in the remote past. For the dimensions of the halo—minute though they be—can be determined with considerable accuracy, and these dimensions are conditioned by the added effects of the several α-rays emitted by the transmuting elements. Bragg and Kleeman observed and measured just such integral ionisation effects in air. In the rocks the ionisation curves, owing to the great stopping power of minerals, are on a scale 2000 times as small. They are very faithful hieroglyphics, however, and carry back our knowledge over an appalling vista of time.

One single α-ray produces a well-known curve of ionisation determined by Geiger. The range of the ray does not affect the general nature of the curve. If we imagine uranium or thorium as parent elements contained in a minute crystal—of zircon, for instance—we must picture the various α-rays affecting the surrounding substance—mica, we may suppose—in such a way as to build up concentric spherical shells more or less overlapping and corresponding to the radial distances at which the ionisation of the several rays is at a maximum. As seen in section upon cleaved flakes of the mica, we find concentric coloured rings representing the ionisation due to the rays.

In order to arrive at the theoretical location of these rings we must add up the several ionisation effects as observed in air. This involves assigning a Geiger curve to each ray according to its range and adding up the ordinates.

Let us consider first the case of the thorium halo. Fig. 1 is a curve arrived at in the manner I have just described. Its ordinates are proportional to the integral ionisation effects of those radio-active elements in the thorium series which emit α-rays. And above it I have marked, calculated into the range in air, the positions of the coloured rings which in biotite we observe encircling a minute mineral particle containing thorium and all the successive products of its transmutation. This, of course, necessitates magnifying the halo enormously—rather more than 2000 diameters. You perceive that the halo very faithfully conforms to the features of the air-curve. It may be of interest to mention that the finding of the third ring led to the discovery of the prominence on the curve which accounts for it. This part of the curve had originally been plotted from an insufficient number of ordinates. This close agreement really reveals a very important fact. The air-curve depends for its dimensions on the ranges of the several α-rays as we measure them to-day in the laboratory. The halo-measurements refer to radio-active effects which began their record in this mica in Carboniferous times—possibly long before. The halo reveals no sign of change in the several ranges concerned. As you are aware, the rate of break up, the transformation constant of the element, is related to the range. We are, therefore, in the case of the thorium family, entitled to read in these minute and ancient records a guarantee that the accumulation of the final product—the thorium isotopes of lead—was in the remote past effected at just such a rate as we have inferred from the splendid researches of our day. The thorium halo gives us this guarantee. It also tells us that it is improbable that the resulting lead is unstable. For if it were we must find room for rays additional to those we have used in deriving the ionisation curve. True, a coincidence of range might enable a ray to lie concealed in the halo; but the fit of the halo is so absolutely faithful to every feature of the curve that this seems improbable.

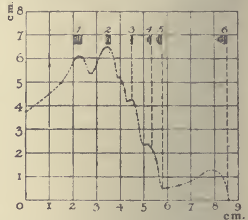


FIG. 1.

It is also possible to observe the successive stages of development in thorium haloes. The first rings to appear are those corresponding to the two conspicuous crests of the curve, Fig. 1. If the central nucleus is small or feeble, nothing more may be developed.

We now turn to the uranium curve. The eight contributory ionisation curves are placed according to the range of each ray, and Fig. 2 shows the curve produced by adding up the ordinates. Above it are laid out the several rings observed in the uranium halo.

Looking at these rings, we notice that the outer features of the halo seem in fair agreement with the present-day ranges. But the innermost ring has a larger radius than would be expected from the curve. Much care has been expended in verifying this point. In the Devonian mica of County Carlow these haloes are found in every stage of development according to the size or activity of the nucleus. The uranium halo

begins as a single delicate ring surrounding the minute central nucleus. It can be measured from a stage bordering on invisibility to a stage when its central area is beginning to darken up and the first shadowy signs of the outermost ring of all—that due solely to radium C—appear. A large number of readings on these embryonic haloes, made recently by various observers, confirm the mean value of is radius as cited in a paper communicated to the Royal Society in 1916. The discrepancy with the theoretic curve is small; 10 or 12 pei cent. of the external radius. The allowance for, and measurement of, the nucleus is sufficiently difficult to introduce some uncertainty.

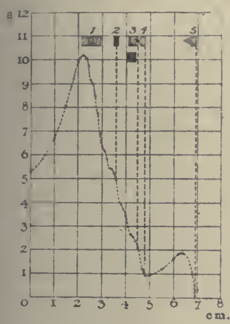


Fig. 2.

This misfit may be of considerable significance. I have already reminded you that the range of the α-ray emitted by a transforming element is related to its rate of break-up. The range is longer for the shorter lived elements. Now here the first ring of the uranium halo in mica shows a longer range than we would expect from the air-curve as observed to-day. The agreement between the two in other cases appears to show that this is not due to any unknown effect influencing the retardation in mica. The location of the first uranium ring is mainly referable to those short-range α-rays arising from the initial transformations of the uranium series. We infer that one or more of these rays must have had a longer range in past times and, of course, that the corresponding transformation periods must have been shorter. A specially influential ray is that slowest of all the rays—that which is emitted in the break-up of uranium 1. The discrepancy might be due to this ray possessing a greater range in early geological times. But, whatever the cause, the nature of the misfit suggests evidently that formerly the rate of transformation of uranium to lead was faster than it is to-day.

It is with some reserve that I refer here to measurements made lately on haloes of comparatively recent and of very remote geological ages. I say "with reserve," for not only are the results of a nature calling for very adequate confirmation, but the measurements present considerable difficulty. The point at issue may be stated in a few words:—Is the abnormality observed in the dimensions of the uranium halo dependent in amount upon the antiquity of the rock in which the halo is developed?

I had sought occasionally for uranium haloes in rocks younger than the Leinster granite—which is of early Devonian age. The granite of Mourne, which is of Eocene or early Tertiary age, for long refused to reveal any haloes suitable for measurement. However, recently, I was so fortunate as to find a few of these early halo rings which I was able to measure. Further search has revealed a few more; but htey are excessively scarce and rather difficult to detect. The nuclei of these haloes are only rarely zircon—they seem to be apatite—possibly allanite—and their average size is greater than the zircon nuclei of the Carlow mica. Both the mineral nature of the Mourne nuclei and their dimensions involve, therefore, a bigger subtractive correction on the observed radius than is required in the case of the Carlow haloes. But in addition to this, there appears to be a small difference in the external radius of the Eocene halo and that of the Devonian halo. According to a large number of readings by several observers, some of whom were not acquainted with the question at issue, the external radius of the Eocene halo-ring—no allowance being made for the nuclear radius—is 0·0135 mm. The same observers obtained for the Devonian halo 0·0146 mm.—without allowance for the nucleus. The nuclear correction, as I have said, would have increased the discrepancy, but the correction is a difficult one. There is no reason to believe that *more* than 1 per cent. of this difference can be ascribed to the chemical composition or density of the micas, both of which have been investigated.

Still more recently I have found these primary ring-haloes in the micas of Arendal and Yitterby, which are said to be of Archæan age, and which are certainly extremely ancient. These haloes appear to possess a radial dimension of 0·0160 mms., or a little less. Here, again, the nature of the mica does not appear to be responsible. According to these measurements it would appear that the radius of the Eocene halo-ring must be increased by about 7 per cent. to attain the size of the Devonian halo-ring, and that this is, in radial dimension, about 10 per cent. smaller than the Archean. It would seem as if we might determine a geological chronology on the dimensions of these halo-rings!

The foregoing results, if confirmed, would give strong support to the view that some factor, variable over geological time, had affected the ranges and periods of certain elements concerned in building up the uranium halo. However, too much stress must not be placed on these measurements till they are confirmed by haloes in yet other micas. Pending further investigations, I return to the fact that the uranium halo of Devonian age does not conform to the ionisation curve of the uranium family as determined on present-day measurements. Serious discrepancy seems confined to the shorter ranges, more especially with that primary range which is most influential in determining the rate of production of uranium lead.

We do not appear to be in a position to deny the possibility that uranium 1 may have slowed down in its rate of decay over geological time. Such laboratory observations as can be extended to the case of short-lived elements would not, probably, shed any light on the matter. It is a possibility long ago suggested by Rutherford. But if this is the explanation we must admit that in the case of thorium any corresponding effect must have been much smaller. On the whole the former influence of one or more isotopes of uranium—which possibly may almost have disappeared—seems the more probable explanation. Hypothetical isotopes of uranium have been invoked by highly competent authorities to meet the difficulties affecting the ionisation accounts of the uranium family of elements. Boltwood suggests as "not impossible"

that what we now call uranium consists of three radio-elements; a parent element and two isotopic products all emitting α-rays (*Phil. Mag.*, July 1920). In 1917, A. Riccard put forward the view that the parent of actinium is a third isotope of uranium not belonging to the uranium family and having an atomic weight of 240. This view is regarded favourably by Soddy and Cranston. It clears up the difficulty respecting the atomic weight of uranium and fits in with the atomic weights of radium and of uranium lead. Soddy and Cranston remark that in order to explain, in this case, the constant ratio of actinium to uranium observed in minerals we must suppose the period of uranium 1 and of the hypothetical isotope to be the same. This difficulty, however, is removed if we may assume that the ratio varied over geological time.

A somewhat similar theory to Riccard's may be invoked to explain the abnormality of the Devonian uranium halo. We have these facts to go on:—The age indicated by uranium for Lower or Pre-Palæozoic rocks is about 4 times too great as compared with the age indicated by thorium. We assume, therefore, that three-fourths of the lead as measured in uranium minerals is derived from a certain isotope. This isotope, not having been detected in our time by its primary α-radiation, we must suppose to be now sensibly exhausted. We, therefore, have a known mass of this isotope transforming to lead in a known time—130×10^6 years. Assuming that only 1 per cent. of it is left we get its transformation constant ($3 \cdot 5 \times 10^{-8}$), and by Geiger and Nutall's relation we find the corresponding range as 2·6 cms. at 0° C.; or about 2·75 cms. at 15° C. To-day the α-radiation of the hypothetical body would be only $\frac{1}{1000}$ of that due to uranium 1, but during the period since the Devonian there will be about 3 α-rays from the short-lived isotope to 1 from the long-lived. The integral curve of ionisation as modified by these hypothetical results would be in agreement with the Devonian halo. We have to assume that the ranges of the rays emitted by the successive disintegrating products of the supposed isotope were such as to leave the outer features of the halo sensibly undisturbed. This seems not improbable.

The salient facts which appear in the study of radio-active haloes are:—firstly, that the agreement of our laboratory measurements of to-day with the features of the Palæozoic thorium halo is such as to support the view that the periods of the several elements concerned in its genesis have remained unchanged over 130 millions of years. This fact, taken along with the stability of thorium lead, seems to render its reading of geological time authentic in a high degree. Its indications are confirmed by the consistent testimony of the denudative processes which have progressed on the earth's surface. Secondly, it appears that the uranium halo is not in conformity with the period we ascribe to-day to uranium; a disagreement which is emphasised by the failure of uranium-time to conform with the united testimony of thorium-time and denudative-time; as well as by much that remains unexplained respecting the earlier changes in the uranium family of elements.

The complete tale is not yet told, but I think the balance of probability is in favour of an age between 150 and 200 millions of years for the earliest advent of geological conditions upon the globe.

Astronomical investigation on the subject of the age of the earth deals, generally, with that greater age which must be ascribed to the earth as a planet. For this age vast periods have been claimed. But it is possible to reconcile superior ages for the earth as a planet with comparatively brief geological time. And—to my mind—in doing so we proceed upon what is no more than a necessary deduction based on our knowledge of the radio-activity of terrestrial materials. I would go further—still, as I believe, logically,—and ascribe to radio-active energy an influence on planetary and stellar evolution much greater than has hitherto been admitted.

The only planet we can investigate at all closely is, of course, our earth. And what do we find? In its surface materials there are sufficient of the radio-active elements, as Lord Rayleigh first showed, to account for the observed average temperature gradient if the surface conditions extend a little way, about 19 kilometres, inwards. It is, for many reasons, in the highest degree improbable that such a definitely defined radio-active layer exists. Nor is it probable that the earth's interior is free from radio-active substances. We find both uranium and thorium in meteorites containing a large percentage of iron and nickel, and, although they have not as yet been found in meteoric iron, we know from the mean density of the earth that its interior cannot be composed of pure iron. It is probable that a considerable proportion (some 40 per cent.) of siliceous materials are intermingled: and when such exists in meteorites invariably we find the radio-active elements. By what conceivable activity was all the uranium and thorium separated out and brought to the surface?

The view that radio-active elements exist in the earth's interior is sometimes met by a formal denial that the earth can be getting hotter within. Upon what evidence is this denial based? If the central core of the earth for a radial distance of 2000 kilometres—say—had risen in temperature by 1000° C. over geological time—and upon a low assumption of the interior radio-activity it might reach this temperature in 150 million years—would we be aware of the fact? Would the day be appreciably lengthened? Would there be any effect at all if the outer parts were cooling due to loss of primal heat? We have further to consider that only over the short period of historical time would any observations be available. The denial is quite baseless so far as my estimates go.

Well, then, if our earth is heating up within, is there not an impending termination to our geological age? Kelvin showed how complete is the thermal isolation of the earth's interior, and it is certain that interior heat is not now escaping. The rise of temperature within must go on till the present epoch succumbs to the accumulated energy. Then must ensue a period of vulcanicity which will end life upon the globe, and probably reverse the chemical work stored up by ages of denudative and organic activity. The whole sequence of events — rapid cooling by radiation, restoration of the oceans and, possibly, re-birth of life and of its evolutionary history—would begin all over again. On this view the Age we have been studying

may be one of many and will inevitably attain its three score and ten; terminating in labour and sorrow. But there must come a rejuvenation, and the rejuvenation, possibly, may one day be pondered by other Minds than ours. Remember that after some ten thousand millions of years there still survives 50 per cent. of the heat-generating elements, and the effect of their diminution is only to lengthen out the recurring geological ages. Our planetary companions may be in various stages of such cyclical changes.

Recovery of Hughes's Original Microphones and Other Instruments of Historic Interest.

By A. A. CAMPBELL SWINTON, F.R.S.

FROM the perusal of David Hughes's note-books recently bequeathed to the British Museum by Mrs. Hughes, and sent to me for examination by the Keeper of the Manuscripts (see NATURE, March 9, 1922, pp. 315-316), it became obvious to me that Hughes must at one time have possessed numerous original instruments, mostly constructed with his own hands. Having been informed that the note-books had been rescued from "an incredible accumulation of useless lumber," it occurred to me to try to locate this "lumber" if still existent, and to see whether it comprised any of the instruments. To make a long story short, a room in a furniture depository not far from the Tottenham Court Road was found to be filled with Hughes's personal effects, which had been stored there since his death in 1900, when Mrs. Hughes returned to America. Having interested Col. H. G. Lyons, F.R.S., Director of the Science Museum, in the matter, the effects were carefully examined, when not only were there discovered eight more note-books—one containing an illustrated account of Hughes's invention of the microphone—but also numerous instruments.

These comprise a number of microphones, of which several are different-sized instruments of the well-known pivoted-lever type. Others consist of pointed carbon pencils, loosely held at their ends between fixed carbon sockets, the whole being mounted on sounding-boards, which in one case takes the form of an inverted Japanese ash-tray. Several more consist of carbon pencils suspended pendulum-wise by paper strips, so as to bridge other carbon pencils mounted on vertical sounding-boards, while others, again, consist of glass tubes containing either carbon blocks held together by a light spiral spring, or carbon granules. Finally, among the microphones, there is the one consisting of three French nails that has served to illustrate many a text-book.

In addition, there is an induction balance, probably the first one that Hughes made, together with the actual instruments with which he practised wireless telegraphy in 1879. They are all readily identified from the illustrated descriptions in the note-books, and include the clockwork with which currents from a single-cell battery, connected to one of the coils of the induction balance, were interrupted so as to transmit wireless signals. There are also two Bell telephones, evidently made by Hughes himself, together with two more which he says were made for him by Sax, which he used for wireless reception in connection with a water-tight pocket battery, and a special microphone that seems to have acted as a self-decohering coherer. This latter is contained in a glass bottle, the loose contact being made between a steel needle and a wire loop, which latter Hughes says he made more sensitive by coating it with soot from the flame of a spirit lamp.

With these simple pieces of home-made apparatus Hughes not only prepared the way for the modern telephone transmitter, but also transmitted and received wireless signals over distances up to 300 yards no less than 43 years ago.

All these instruments have been made over to the Science Museum, South Kensington, by Mrs. Hughes's trustees, and are now on view in Room No. 10.

Obituary.

WE learn from the *British Medical Journal* that Dr. Harris Graham died at Beirut, Syria, on February 27. Dr. Graham, who was in his sixtieth year, was of Canadian birth and was educated at Toronto and Michigan Universities. Going to Turkey as a missionary he served four years at Aintab Medical College. On its closure, he was called to Beirut and joined the American University there in 1889. During various leaves of absence he worked in Berlin and Vienna, and advanced evidence that a Culex mosquito is the carrier of dengue fever. He had an extensive practice and spoke all the principal languages of the Levant. Dr. Graham will be much missed, for he was an energetic and inspiring teacher and a physician of great acumen.

THE *Chemiker Zeitung* of March 25 announces the death, at the age of eighty-four years, of Prof. A. Naumann. Prof. Naumann was one of the first workers in the field of what is now called physical chemistry. His researches on dissociation, thermo-chemistry, and mass action, and his text-book had great influence on the science; his name is prominent in all the earlier work in this field.

THE death is announced, at the age of fifty-one years, of Dr. George Vincent Wendell, who had occupied a chair of physics at Columbia University since 1910. From 1892 to 1907 he held various posts at the Massachusetts Institute of Technology, and from 1907 to 1910 he was professor of physics and head of the department at the Stevens Institute of Technology, New Jersey.

WE deeply regret to record the death on April 9, at seventy-seven years of age, of Sir Patrick Manson, G.C.M.G., F.R.S., whose pioneer work on tropical diseases opened up fields of research of profound significance both to science and civilisation.

Current Topics and Events.

The centenary of the birth of Pasteur occurs this year, and the University and town of Strassburg, the scene of so much of Pasteur's early work, propose to celebrate the event by organising an exhibition of hygiene and bacteriology from May to October 1923, and by setting up a statue of Pasteur before the University. The exhibition will be designed to illustrate the advances in science made as a result of Pasteur's discoveries, and a congress for the discussion of questions relating to the prevention of disease will also take place. In this country a committee, consisting of Sir Charles Sherrington (chairman), Mr. A. Chaston Chapman (treasurer), Mr. H. E. Field, Prof. P. F. Franklin, Sir John M'Fadyean, Prof. C. J. Martin, Sir W. J. Pope, Sir James Walker, and Sir Almroth Wright, has been formed to forward the project and an appeal for support has been issued. Contributions to the memorial fund, which will be closed at the end of June, should be sent to Mr. Chaston Chapman, The Institute of Chemistry, 30 Russell Square, W.C.1, or to the general secretary and treasurer of the fund, M. T. Hering, 6 rue des Veaux, Strassburg. Prof. Borrel, 3 rue Koeberlé, Strassburg, is in charge of the arrangements for the exhibition and would be glad to hear from British firms who are interested. The Académie de Médecine has decided to celebrate the centenary on December 26 next, but representatives of the academy will be present at the celebrations to be held at the Institut Pasteur on December 27 next and at Strassburg on June 1 of next year.

The centenary of the birth of Gregor Mendel is to be celebrated in Brünn (Czecho-Slovakia) on September 22-24 of this year, and subsequently, on September 25-27, a congress of geneticists is to be held in Vienna. The circular of invitation recalls the erection of a statue to Mendel there in 1910. Since that date the significance of his discovery and the extraordinary importance of his work in its bearing on the fundamental conceptions of biology and the practice of breeding have been so widely recognised that international support on the present occasion is confidently invited. Those who are disposed to take part are asked to communicate with Dr. H. Iltis, Bäckergasse 10, Brünn.

We have received from the authorities a preliminary circular announcing the celebration this spring of the seventh centenary of the University of Padua, one of the oldest and most famous of the Italian universities, immortalised by Galileo and his successors. In connection with the celebrations a very interesting historical account of the University is published in the February number of *L'Emporium*, the leading art journal of Italy, showing the bearing of the University upon education in the Italy of past centuries, and the vicissitudes through which the institution passed down the ages. In spite of its associations with the great names of the past, Padua is a very modern university in so far as concerns present-day needs, ample proof of this being the large and well-equipped school of electrotechnics.

Since the School of Hygiene and Public Health of Johns Hopkins University, Baltimore, was opened in 1918, the Rockefeller Foundation has furnished funds for its maintenance from year to year. Now the Foundation has presented a sum of 1,200,000*l.*, and the trustees of the University are to assume full responsibility for the future needs of the School. In this new type of institution emphasis is laid upon the development of preventive medicine and the training of health officers. Instruction is provided in bacteriology and immunology, sanitary engineering, chemical and physiological hygiene, medical zoology, epidemiology, vital statistics and public health administration, and the regular courses of study lead to the degrees of doctor of public health and doctor and bachelor of science in hygiene. The present gift, in addition to providing endowment, will make possible the erection of the new building for the School on a site adjacent to the Johns Hopkins Medical School and Hospital.

Prof. A. Wolf, of the University of London, delivered a lecture on the Humanism of Spinoza at a special session of the Spinoza Society held at the Hague on Tuesday, March 28. The Spinoza Society ("Societas Spinozana") is the offspring of an older society founded more than forty years ago when the Spinoza monument was erected in the Hague as an international tribute to the great philosopher. Among the leading spirits of both societies are Sir Frederick Pollock, of London, Prof. L. Brunschvieg, of Paris, Prof. H. Hoeffding, of Copenhagen, Dr. C. Gebhardt, of Frankfurt, Dr. W. Meyer and Mr. H. G. van der Tak, of the Hague. The Spinoza Society has now in the press the first number of an Annual to be called "Chronicon Spinozanum," to which all the above-mentioned Spinoza scholars and others have contributed important essays. The promoters of the new society and its annual are prompted by the feeling that a wider knowledge of the philosophy and personality of Spinoza may be of special help in these difficult times, and they hope that the society may become a rallying point for those thinkers who still share Spinoza's faith in the ultimate unity and rationality of mankind.

In appointing an advisory Committee in Seismology, the Carnegie Institution of Washington has taken an important step in the promotion of the study of earthquakes in the United States. The preliminary report of the committee recognises that, as compared with England, Germany or Japan, the country has not yet taken a sufficiently active part in seismological research. At the same time, in the State of California, it possesses almost unexampled opportunities for the study of crustal movements, while several public

bodies are prepared to co-operate in such a study. The committee make several useful suggestions. Detailed surveys, it is urged, should be made of the San Andreas rift and other Californian faults. The Coast and Geodetic Survey should be invited to undertake a system of primary triangulation and precise levels in the regions most subject to movement, and to connect them with an appropriate zone of no movement east of the mountains, and also to erect new lines of columns at right angles to the San Andreas and San Jacinto faults, a time like the present being more suitable for the measurement of crustal drift than the months immediately following a great earthquake, such as that of 1906. Southern California, especially, is a region of intricate faulting, in which many of the faults are still active, and it is also one in which no primary triangulation has yet been made. The committee also indicates the value of gravity observations in connexion with the measurement of displacements along the great faults.

Sir Arthur Newsholme delivered a course of three Chadwick lectures at Birmingham on March 27-29. The subject of the first lecture was "Values in Preventive Medicine historically considered: General and Specific Sanitation." The lecturer dealt with the value of various measures against disease in their historical development. He deprecated strongly the undiscriminating call for retrenchment in public health expenditure, though urging a careful survey of the cost of all measures in vogue. The epidemiology of typhoid fever, cholera, typhus fever, and others was considered, and the lessons taught by the methods of control were surveyed. In the second lecture on "Current Values in Preventive Medicine: Relation between Prevention and Treatment," Sir Arthur Newsholme reviewed the possibilities of preventing the chief infectious diseases. The acute notifiable diseases cause only 3·1 per cent. of the total mortality, though the greater part of administrative care is devoted to them. In childhood more than half the deaths are due to infections, and in a large measure adult health is determined by disease or absence of disease in childhood. The chief object of preventive medicine is to postpone death, and this would be greatly aided if every adult submitted himself to periodical medical examination. In the third lecture, methods of evaluating public health activities were considered. Empiricism in analysis of social conditions was deprecated, as, for instance, in statements on malnutrition of school children, without further attempt to ascertain the cause. The amount spent on public health in large English and American towns averaged 5*s.* per head per annum, or, in England, from 4 to 8 per cent. of the total rates collected per head. The importance of minimum standards was emphasised, each town to receive a government grant only when it fulfilled certain minimum conditions. The lecturer concluded that the greatest return in health for money expended—apart from the ordinary sanitation of a city—was to be had in respect of maternity and child welfare, and on the prevention and treatment of tuberculosis and venereal diseases.

The *Times* reports the opening on April 5 of a lock and weir at Blanchetown, South Australia, the first of a series of such structures which will ultimately number 26, and directs attention to the very important scheme of navigation and irrigation, of which they form part, entered upon by the States of New South Wales, Victoria, and South Australia, with the sanction of the Federal Government. The rivers Murray and Murrumbidgee are to be regulated by a lockage system which will make it possible to navigate their waters for a distance of 1066 miles above the mouth of the former, and at the same time will increase greatly the area of irrigable land. Of the total number of locks, nine will be constructed by the New South Wales Government on the Murrumbidgee, eight by the Victorian Government on the Murray, and nine by the South Australian Government on the same river. The Blanchetown lock, which has been named after Mr. W. R. Randell, one of the pioneer navigators of the river, is situated 170 miles from the sea, and marks the limit of free deep water, for which reason it was chosen as the initial feature of the undertaking. The work, which was begun seven years ago, has been much impeded by floods and industrial troubles, so that the lock was only completed in September last.

Lectures at the Royal Institution after Easter will be resumed on Tuesday, April 25, when Sir Arthur Keith will begin a course of three further lectures on "Anthropological Problems of the British Empire," Series II.: "Racial Problems of Africa." The Tyndall Lectures will be delivered this year by Prof. W. Bulloch on "Tyndall's Biological Researches and the Foundations of Bacteriology," and Sir Percy Sykes will give two lectures on Persia. On Thursday afternoons there will be two lectures by Prof. E. H. Barton on "Audition and Colour Vision"; two by Prof. F. Keeble on "Plant Sensitiveness." On Wednesday, April 26, Prof. D. H. MacGregor gives the first of two lectures on "Industrial Relationship," and on Wednesday, May 24, Dean Inge begins a course of three lectures on "Theocracy." On Saturday afternoons there will be two lectures by Prof. O. W. Richardson on "The Disappearing Gap between the X-ray and Ultra-violet Spectra"; and three by Sir Hugh Allen on "Early Keyboard Music," with musical illustrations by Mr. Harold Samuel. The Friday evening discourses will be resumed on April 28, when Dr. Arthur Harden will deliver a discourse on "Vitamin Problems." Succeeding discourses will probably be given by Dr. M. Grabham, Dr. H. H. Dale, Sir William Bragg, Prof. W. E. Dalby, the Hon. Maurice Baring, Mr. J. Barcroft, and other gentlemen.

At the anniversary meeting of the Royal Irish Academy held last month Prof. T. H. Morgan (New York) and Prof. Jules Bordet (Brussels) were elected honorary members in the section of science.

It is stated in the *Chemiker Zeitung* of March 23 that Prof. W. Nernst will take over on April 1 the duties of Director of the Physikalisch-Technische Reichsanstalt, but will continue to act as Rector of the University of Berlin until October 15.

According to a brief despatch from Valdivia published in the *Times* of April 6, great volcanic eruptions occurred in southern Chile, to the south-east of Puerto Montt, and close to the Argentine border. They were accompanied by violent earthquakes. Much damage was caused to grazing lands on the Argentine side of the frontier, which for thirty leagues was covered with volcanic ashes.

We learn from *Science* that a meeting to initiate the Gorgas Foundation Memorial, founded in memory of the late Maj.-Gen. W. C. Gorgas, who accomplished noteworthy work in connection with tropical diseases in Panama, was held at Birmingham, Alabama, on March 4 last. Among the speakers was the British ambassador, Sir Auckland Geddes, who said: "The name Gorgas will live long after the peoples of earth have forgotten the heroes of the world's greatest war."

At the annual general meeting of the Chemical Society held at Burlington House on March 30, the following new members of council were declared elected: Vice-Presidents, who have filled the office of President: Prof. H. B. Dixon and Prof. P. F. Frankland; Vice-Presidents, who have not filled the office of President: Prof. E. C. C. Baly and Prof. T. M. Lowry; Ordinary Members of Council: Dr. C. Dorée, Dr. J. J. Fox, Prof. I. M. Heilbron Prof. J. W. McBain, Dr. W. H. Mills and Prof. J R. Partington.

Under its new constitution the Association of Assistants in Pathological and Bacteriological Laboratories is now admitting, as associate members, laboratory assistants from laboratories other than those of pathology and bacteriology. The organisation was founded in 1912, its chief object being to improve the status of the laboratory assistant by endeavouring to raise the standard of technical knowledge through the medium of an educational programme, culminating in an examination and the granting of a certificate of proficiency in laboratory technique. An official organ, *The Laboratory Journal*, is issued to members quarterly, and, in addition to Association news, the journal contains original articles and abstracts of technical interest to laboratory workers; there is also an employment bureau. From the first the founders had in mind the inclusion ultimately of all laboratory assistants in one federation, and it is hoped that the present movement will lead to the formation of sections embracing other branches of science. The Honorary Associate Secretary is Mr. F. C. Padley, 2 Eldon Place, Reading, from whom further information may be obtained.

Our Astronomical Column.

Evening Stars.—After sunset the sky now presents some interesting planets for observation. At the middle of April Venus will be brilliantly displayed in the western sky, and sets about an hour and a half after the sun has gone down. Jupiter will be visible in the south-east sky and will pass the meridian at an altitude of about 35° soon after 11 p.m. Saturn crosses the meridian 35 minutes before Jupiter, as it is situated 9° westwards.

Mars will not be visible in the early hours, but rises at midnight at the middle of the month, and will remain visible throughout the morning hours. Jupiter and Saturn may now be very successfully observed in telescopes, as they reach a fairly good altitude, but Mars is very low in Scorpio and only 15° above the horizon when due south. The latter planet will continue so far south during the ensuing summer that its markings will scarcely admit of satisfactory investigation by European observers. When the planet is nearest to the earth on June 18 next, it will be only 42 millions of miles distant from us, but its greatest altitude will not exceed 12°. In such circumstances good definition of delicate features is almost impossible when high magnifying powers are employed on telescopes.

The Distances of the Short-Period Cepheid Variables.—Bull. No. 8 of the Astr. Inst. of the Netherlands contains an important research on this subject by J. C. Kapteyn and P. J. van Rhijn. They note that the Cepheids may be divided into two classes with periods greater and less than 16 hours. Excluding those in clusters, there are 39 and 94 stars belonging to these classes respectively; the first class shows no galactic concentration, while the second shows it strongly, an argument for the relative proximity of the former. Provisional proper motions are deduced for 14 of these stars, chiefly from astrographic plates with a time-interval of some 25 years. The mean parallax deduced is 0·0065″, while the mean magnitude is 10·3; the parallax is 7·6 times as great as that given by Shapley's formula. It is pointed out that Schouten reached in 1918 the same factor 7·6 for Shapley's parallaxes of the clusters; he based this on the assumption that the luminosity curve for the stars in the clusters is identical with that found for the stars as a whole. It should be observed that neither method affects the relative distances of the clusters investigated by Shapley; it simply divides all of them by a factor. Further, the Cepheid method was only one of several used by Shapley in deducing his distances; hence it appears somewhat unlikely that they need division by so large a factor as 7·6.

Kapteyn and van Rhijn also reinvestigate the mean parallax of the long-period Cepheids, obtaining 0·0029″ from 17 stars, of mean magnitude 5·32, which is in good agreement with Shapley's 0·0034″ from 11 stars. They express the hope that trustworthy proper motions for all the 39 short-period Cepheids will be available in a few years, and ask for a suspension of final judgment on the distances of the clusters till that time.

Dr. Shapley gives some evidence on the other side in Harvard Coll. Observ. Bull. No. 765. He states that the light curves of several short-period Cepheids in the Small Magellanic cloud (mean period 0·64 days) give a mean median magnitude 16·1, closely agreeing with the value 16·2 predicted by his curve. He claims that this supports his previous estimate of the absolute magnitude of these stars.

Research Items.

An Artifice of Nectar-Sipping Birds.—In a communication sent to us by Mr. P. M. Debbarman of the Royal Botanic Gardens, Sibpur, Calcutta, he records that the flowers of *Castanospermum australe* are visited by the nectar-sipping bird *Mirafra assamica* in India. The beak of this bird is not sufficiently long to reach the nectar in the calyx cups, so the bird appears to have adopted the practice of biting off the fleshy petals which obstruct it. The tree is not a native of India but is of Australian origin, and it would be interesting to know whether any nectar-sipping birds attack the blossoms of this tree in Queensland, where it is native.

Ice in the Arctic Seas in 1921.—The annual publication of the Danish Meteorological Institute (*Isforholdene i de Arktishe Have*) shows that ice conditions last year in the Barents and White Seas were somewhat unusual. The eastern part of the Barents Sea was free from ice early in May, while in the north the edge of the pack was more northerly than usual throughout the summer. The White Sea was easily accessible and almost free of ice as early as April. On the west coast of Spitsbergen, there was considerably less ice than usual during the winter 1920–21. The fjords were frozen only for short periods and pack-ice did not appear off the coast in any quantity before May, but throughout the summer months there was a belt of loose pack off the south-west coast, which in October increased in width to some 70 miles. This occurrence was associated with the prevalence of easterly winds in the Barents Sea in summer. The same winds caused the ice to be packed against the east coast of Greenland in July and August. The distribution of ice in the Greenland Sea was normal except in this respect, which made the east coast of Greenland singularly unapproachable. On the Newfoundland banks ice-bergs were very numerous in May and again in July, when they drifted rather far south. In the Bering Sea, the edge of the pack seems to have been more northerly than usual in spring. In the Beaufort Sea a whaler reached Banks Land in August.

Seismological Stations of the World.—A valuable catalogue, and the most complete so far issued, of the seismological stations of the world has been compiled by Mr. H. O. Wood under the auspices of the Section of Seismology of the American Geophysical Union (published by the National Research Council of the National Academy of Sciences, Washington, 1921). The total number of stations is about 315, and for each is given, when known, the position and the nature of the foundation, the names of the director and of the supporting institution, the types of seismographs used and the constants of each, and the method of obtaining correct time. With regard to more than 90 of them (including all the Russian stations), however, no recent details have been communicated. Arranging the stations according to countries, we find that Japan heads the list with 55, followed by the British Empire and Italy with 42 each, the United States with 32, and Germany with 21. The instruments used are almost as diverse as the countries. The most popular is the Wiechert inverted pendulum, of which there are 72 in use with masses varying from 80 kg. to 17,000 kg. at Göttingen and Tacubaya (Mexico) respectively. Then come the Omori horizontal pendulum, extensively used in Japan, the Milne seismograph, chiefly at British stations, and the Vicentini seismographs, employed as a rule in Italy. The costly, but effective, Galitzin seismographs are in working order at not less than eight stations. Two points of some interest are the large number of stations founded during and since the war and not in neutral countries only, and the gradual replacement of the older instruments by others of more recent and accurate types.

The Cement Oilfield, Oklahoma.—A recent addition to our knowledge of the Mid-Continental Oilfield region of North America has been made by Mr. F. Reeves in Bulletin 726-B of the United States Geological Survey, wherein he deals with the geology of the Cement Oilfield, Caddo County, South-west Oklahoma. The area described occurs to the north of one of the main uplift masses (Wichita Mountains) which form such a conspicuous feature of the country bordering northern Texas, and the local tectonics of the field have intimate connection with this larger element of structure. The surface geology is mainly Permian (Red Beds), forming a vast plain surrounding the Wichita Mountains. This formation consists of shales, sandstone, gypsum and limestone, and, according to the author, has a total thickness of 1500 feet. Beneath it lies the Pennsylvanian Series, and it is presumed that the oil is obtained from the upper beds in this series, though some difference of opinion is manifest as to where the line of junction should be drawn, the transition from the older to the newer rocks being very gradual. The principal structural feature of the Cement area is the Cement anticline with its complementary synclines, the Cobb on the north and the Cyril on the south. The trend of these folds is approximately N. 70° W., a strike direction characteristic of the Wichita Mountains. The wells are located practically on the crest on the Cement fold, and have an average daily production of about 100 barrels; twenty-six wells have at present been drilled. The oil is of uniform quality with specific gravity ranging from 0·84 to 0·85. The prospects of the field are good, though it is unlikely that any startling developments will take place in the future, as the productive area is not great and the tendency seems to be for the wells to give low production with slow decline, the rate of decrease averaging 2 per cent. per month. Four gas wells have been drilled and the initial production was good, but the rate of decline of these wells was very rapid. The Bulletin itself is quite up to the usual standard of Survey publications in the matter of descriptive text and particularly in the maps and plans accompanying it.

Land and Sea Breezes in the Gulf of Lions.—An article by Prof. M. Moye is given in the *Meteorological Magazine* for March on land breezes and sea breezes on the French and Catalonian coasts of the Mediterranean Sea. They are stated to be a distinctive feature of the summer climate in these parts, and are said to be much more marked than on the Channel and Atlantic shores. From a discussion by Prof. E. Fontséré, it is shown that at Barcelona sea breezes begin in March, when they blow on about four days out of ten. In April and May they blow on more than six days out of ten, and from July 15 to August 15, sea breezes are recorded on nine days out of ten. In September they are less frequent, and by the end of October they practically disappear. At Montpellier sea breezes are said to be rare before mid-May and after September. The sea breezes generally begin after a short period of calm. During the night and in the early morning land breezes blow gently. The sea breeze begins from the south and south-

west, and the direction is from south-west or west-south-west in the afternoon. The land breezes at night blow from north-west or north. Sea breezes generally blow more strongly than land breezes. A normal sea breeze at Barcelona corresponds with 4 or 5 on the Beaufort wind-scale, whilst at Montpellier the breeze is rather lighter, not exceeding force 3 or 4. Land and sea breezes are said to be essentially surface currents and they are supplemented by a return circulation in high atmosphere. These points have been tested by pilot balloons and the results given are decidedly instructive.

United States Temperatures. — The U.S. *Monthly Weather Review* for November 1921 has an article on "Some Characteristics of United States Temperatures" by Prof. Robert De C. Ward, of Harvard University. The author has had access to maps prepared by the U.S. Weather Bureau for the new Atlas of American Agriculture. The temperatures are not reduced to sea level. In the opinion of the author the isothermal maps of the United States will supersede all previous maps and will for years to come remain the "standard set." Isothermal lines are given for each 5° F., and those for midwinter and midsummer run fairly smoothly and symmetrically to the east of the Rocky Mountains, but the effects of the Appalachian topography warp the local irregularities of the lines. Over the western plateau and mountain area, the isotherms are most irregular, and it is there that the new charts, which show actual temperatures, are so great an advance on those previously drawn. The greatest differences in temperature in different parts occur in the winter. In January, going southwards the temperatures increase about 2°·5 for each degree of latitude. Very different conditions exist in midsummer, when the distribution of temperature is far more uniform and the difference of temperature for each degree of latitude amounts only to about 1° F. Highest and lowest "record" temperatures are given on separate maps produced from the results at about 600 stations. These extreme temperatures are of considerable interest, and if they do not show the world's highest and lowest readings, they give very valuable results. In the United States, especially in the eastern parts, very low temperatures commonly penetrate far to the south into latitudes where the winters are distinctly mild.

Submarine Periscopes.—The current number of the Transactions of the Optical Society contains a paper by Dr. Alexander Gleichen on the path of rays in periscopes having an inverting system comprising two separated lenses, in which results are given of a theoretical investigation carried out by the author for Messrs. C. P. Goerz of Berlin-Friedenau. The paper is devoted generally to the design of periscopes as regards the best arrangement and sizes of the various optical parts involved, with the object of making the best possible use of the available space, which in the case of submarine periscopes particularly is very limited. The characteristics of these instruments are their comparatively great length and small diameter. In particular it is shown how the magnification, the field of view, and the illumination in the centre and at the edge of the field of view, depend on the length and diameter of the instrument, in order to derive therefrom the most advantageous optical arrangement. A feature of submarine periscopes which limits the design to an important extent is the reduction of the diameter of the upper portion which may be extended above the surface. Formulæ for the determination of the path of the rays in periscopes of this type are given and also a brief statement regarding the external form of the submarine periscope.

Crystal Structure of Common Elements.—In a paper published in the Journal of the Franklin Institute for February under this title, A. W. Hull gives a very useful summary of the results of X-ray crystal analysis. The methods of analysis which were first developed (analysis by means of a Laue photograph, or with the X-ray spectrometer) can be used only if a single homogeneous crystal of appreciable dimensions is available. It was impossible to examine the structure of a large number of the elements and simple compounds, which could be obtained only in a finely divided crystalline form, until the "powder method" of analysis was developed by Debye and Scherrer, and by Hull. A mass of powdered crystalline material is placed in the path of a narrow beam of monochromatic X-rays and the crystal structure is deduced from the manner in which the rays are diffracted. The technique of the powder method of analysis has been brought to a very high degree of perfection by Hull, who has examined a large number of elements and compounds. We now know the crystalline structure of thirty-five of the elements, twenty-nine having been determined by Hull himself. A number of binary compounds have recently been analysed by Davey, using the Debye-Hull method. A list of all crystals whose structures have been completely determined is given by Hull. The powder method of analysis will certainly become a most powerful means of studying the structure of solid bodies. It can be applied to any crystalline substance, and in addition, it can be used to analyse constituents of a mixture of crystalline bodies, so that to the metallurgist it will be of the highest importance. The paper concludes with an interesting discussion of "atomic diameters."

The Lighting of Public Buildings.—An interesting paper on this subject was read by Messrs. E. H. Rayner, J. W. T. Walsh, and H. Buckley of the National Physical Laboratory, at the meeting of the Illuminating Engineering Society on March 28. The paper was devoted mainly to experiments undertaken in co-operation with H.M. Office of Works, one noteworthy installation being the semi-indirect lighting in the new Pensions Offices at Acton. The tabulated data show that the level of illumination provided in public buildings has arisen considerably during recent years, values from 3 to 4·5 foot-candles now being general. Another section of the paper was devoted to some experiments on the lighting of picture galleries, where the avoidance of reflected images in the glass on pictures is a difficult problem. Diagrams were presented showing a new arrangement of the skylights which, while occasioning some loss in light, seems to give a much more satisfactory distribution of illumination. The authors also described a special building erected at the National Physical Laboratory for the purpose of experiments on illumination, which has some interesting features. Following the presentation of the paper Capt. J. W. Liberty, Public Lighting Inspector to the City of London, showed a number of photographs of recent lighting installations in certain public buildings, where architectural and decorative considerations play an important part. Amongst such interiors may be mentioned the Guildhall, the Marylebone Town Hall, and the new Port of London building. Some of these interiors, notably those panelled in very dark walnut, present interesting lighting problems. The arrangement adopted in the main office at the Port of London building, where gas-filled lamps giving 20,000 c.p. are assembled in a vast white dome, is particularly striking, and it is hoped to present fuller details of this installation when completed.

Auxiliary International Languages.[1]

By Prof. F. G. Donnan, F.R.S.

At the present day the rights of all nations to unity, to the preservation and independent development of national life and customs, are fully recognised and admitted. Partly as a result of the war, long dormant hopes and moribund languages have awakened to a new period of life and activity. We live amidst a remarkable efflorescence of national diversity and national pride.

At the same time, the material means of intercommunication by land, sea, and air are rapidly increasing in speed, efficiency, and cheapness. You can lunch quietly and leisurely in Amsterdam and the same afternoon have tea with a friend in London. Science and industry are advancing with giant strides, and in rapidly increasing measure all nations are taking part in this work. The modern world is thus a vast arena of conflict between separating and intermixing forces. In the loom of life a myriad coloured threads are intertwined in the strange fabric of modern civilisation. But where are the integrating influences that will give us that *unity in diversity* which all wise men seek?

It is not a monotonous unison of thought that I mean, but a harmony of independent notes—an integration, and not a unification, of separate ideas. What is it that, while conserving the independent life of nations, will produce a common liberality of thought and action? There is only one answer—the intercommunication, the internationalisation of thought. Men have dreamed of a common political organisation of the world, of a human family one in government, speech, and religion. Such things may perhaps come to be, but they lie in the shadowy realm of a very distant future. The practical problem of to-day is the problem of mutual intercomprehension, of unity of understanding, amidst variety of thought, speech, and action. The solution of this problem lies in the existence of an auxiliary language common to all the nations of the world; what we may therefore call an auxiliary international language.

As late as the eighteenth century, Latin served the purpose of an auxiliary international language for the learned world, whilst French has long held sway as the common language of diplomacy (though recent events have tended to give English an equal rank). It may come to pass in the distant future that one of the great modern languages will be gradually accepted by all nations as a common auxiliary tongue known to and used by all. Many Englishmen fondly believe that this high destiny is reserved for their mother language. The very unphonetic character of English spelling presents a great difficulty in this connection.

Those who have given the greatest amount of study to this subject have come to the conclusion that the world will not accept any living national language as a common medium of intercommunication. Feelings of national jealousy, prestige, and advantage are too strong. The international auxiliary language must be *neutral*. It must also be simple and regular, and simplicity and regularity are not qualities possessed by any living national language. From various points of view Latin would satisfy the condition of neutrality, and there are some who urge the claims of this language. But apart from other obstacles, the intrinsic difficulty of Latin is too great.

The object of an auxiliary international language is not to displace or replace existing languages, but to protect and supplement them. These qualities of neutrality, simplicity, regularity, and compatibility can be obtained only by means of an *artificial auxiliary language*. Now this word *artificial* shocks and frightens people. We are so accustomed to the historical and analytical treatment of languages that we have never dreamt of the possibilities of synthesis. The chemists and physicists have analysed nearly all the things they have found in this world. But if they had rested content only with analysis, the practical world would have much less to thank them for. We may not like synthetic butter and synthetic milk, but we have no objection to synthetic soap or synthetic glass. Why not then a synthetic language? So far as the languages of North and South America and of Western Europe are concerned, the problem is mainly one of the synthesis of existing elements, since amongst these languages there exists already a very large international vocabulary. As Dr. Cottrell has aptly expressed it, our problem is nothing less and nothing more than the science of synthetic linguistics. Looking at the matter from this point of view, we see that the word "artificial" is a misnomer. It is true that the first attempts to solve the problem of an auxiliary international language might be fitly termed artificial. They take us back to the seventeenth century. Impressed by the logical manner in which mathematical symbolism represents complex trains of thought in a form at once intelligible to mathematicians of all countries, some of the greatest philosophers and mathematicians of that century conceived the idea of an international language which would be a logical algebra of general thought. Descartes in 1629 discussed this idea in a letter to his friend Mersenne. Leibniz devoted many years to the problem, though he considered that for immediate practical purposes a simplified and regularised grammar applied to the word elements of Latin would provide the best solution.

Language systems of this sort are called "philosophical" or *à priori*. In their construction we might endeavour to make a list of all the primary ideas, and assign arbitrary written symbols, which may be also pronounceable sounds, to these. With the various permutations and combinations of these symbols we might then form all derived ideas. It is clear that from a very few symbols we can easily, by means of their permutations and combinations, form thousands of derivatives. When the number of primary ideas or elements is relatively small, such systems are of great use and are largely used. The various special codes used in international commerce are examples of this method. Another example of such an international code language may be seen in the nomenclature and symbolism of chemistry.

Thus "H_2SO_4" and "para-nitro-anilin" are intelligible to chemists of every nationality. But for general purposes such systems would become exceedingly complex. Moreover it would be very difficult to draw up a simple and fixed table of primary and fundamental ideas, for although the fundamental data of sense may remain invariable, the intellectual activity of the human mind is constantly penetrating the screen of sense-perception. Thus new concepts and ideas in accord with our progressive discovery of the real structure and activity of the world are constantly being formed.

The inventors of *à priori* philosophical languages have, however, usually proceeded in a somewhat different fashion, their object being to construct a vocabulary that would be based on a rational system of classification corresponding to our knowledge of things. Thus in the seventeenth century a

[1] From a discourse delivered at the Royal Institution on Friday, March 24.

Scotchman, George Dalgarno, and also the celebrated Bishop Wilkins—one of the founders of the Royal Society—produced two such philosophical systems. That of Bishop Wilkins was entitled "The Essay towards a Real Character and a Philosophical Language" (London, 1668). In the eighteenth century the disciples of Condillac, the Ideologists, took up the problem of an artificial language considered as a classification and notation of ideas; whilst in the middle of the nineteenth century the learned Spanish professor, Bonifacio Sotos Ochando, published a very perfect system of this type, in which both the grammar and the vocabulary were very fully worked out.

In his "Lectures on the Science of Language" delivered before the Royal Institution fifty-nine years ago, Max Müller discussed the possibility of an artificial language, and gave an account of the system of Bishop Wilkins. Speaking in this connection he said: "It is the fashion to laugh at the idea of an artificial, still more of a universal language. But if this problem were really so absurd, a man like Leibniz would hardly have taken so deep an interest in its solution. That such a language should ever come into practical use, or that the whole earth should in that manner ever be of one language and one speech again, is hard to conceive. But that the problem itself admits of a solution, and of a very perfect solution, cannot be doubted."

In order to understand the method employed by Bishop Wilkins, I give here the basis of his system of classification:—

System of Bishop Wilkins.

	A. Transcendental Notions	Divided into 6 Genera.
Five Categories of Logic	*B.* Substances *C.* Quantities *D.* Qualities. *E.* Actions *F.* Relations	Divided into 34 Genera.

These 40 fundamental genera were subdivided into numerous species, and to all these genera and species letters of the alphabet were assigned in a regular ordinal manner. Thus the genus "element," one of the types of "substance," was denoted by De. Now Bishop Wilkins followed the peripatetic philosophy and divided the genus element into the species earth, air, fire, and water.

Substance

Element = De

Fire = Deb

Flame = Deba

De = Element; Due = elementary.
Do = Stone; Duo = stony.

Fire thus became Deb, and flame, a variety of fire, became Deba. Grammatical function was indicated by appropriate letters, *e.g.* De = element, Due = elementary. Do = stone, Duo = stony.

We can perceive here two of the fundamental objections to all such philosophical systems. In the first place all such classifications are fleeting and transient. At best they can but reflect the knowledge and science of their day. But as this is constantly changing there is no finality. We no longer accept the earth, air, fire, and water of the Aristotelian-scholastic philosophy as a satisfying classification of elementary substances. Even the chemical elements of twenty-five years ago are dissolving before our eyes into the electrons, protons, and neutrons of a newer philosophy. But even were there a finality of knowledge, such classificatory symbolisms would be very difficult to memorise. We should have to remember not only the symbols and their meanings, but also the whole ordinal system of assignment. In practice we should have to learn the system empirically as we do natural living languages. Thus all the hoped-for advantages would disappear. To a child *Deba* might soon come to mean flame, but if we came across this mysterious word in later life we should have painfully to de-code it.

The modern era, the era of synthetic or *à posteriori*, as contrasted with purely *à priori* languages, began with Volapük. This was the discovery of Monsignor Johann Martin Schleyer, a Roman Catholic priest of Baden in Germany, and was given to the world towards the end of the year 1880. His vocabulary consisted of root-words, derived words, and compounds. Schleyer endeavoured to borrow his root-words from the international stock, so that the greatest number of persons might have the fewest unfamiliar words to memorise. He stated himself that the Volapük Lexicon was based mainly upon the English language, because it was spoken by 100 million people. Unfortunately for the 100 million, these roots were so changed by Schleyer that a very large number of them became unrecognisable in the written language. There were several reasons for this. His system was a phonetic one, but the sounds corresponding to several of his letters were so chosen as to destroy the international appearance of the roots. No stem or root which was declinable could end in the sibilant consonants *c, j, s, x*, and *z*, since the plural was formed by the letter *s*. Monsignor Schleyer held that the letter *r* offered such difficulty of pronunciation to children, Englishmen and Chinese—a majority of mankind—that it had to be very largely eliminated. For *r* he substituted very often the letter *l*. Finally he made his roots as monosyllabic as possible.

The net result of these transformations was that many roots chosen from English, or other languages, on account of their internationality, became unrecognisable.

Volapük belongs to the class of "mixed" languages in which borrowed and arbitrary elements are more or less logically combined. Nevertheless, in spite of its many difficulties and its *à priori* elements, it represented an enormous advance on the purely artificial or *à priori* systems of Wilkins, Sotos Ochando, and many others. It presents us with the first great attempt to build up from a small stock of existing root-words a synthetic auxiliary international language based on an autonomous system of word-formation and on a perfectly regular inflexional grammar. In its day, it had a great success. At first it spread slowly, but about 1885 it was actively taken up in France, its chief partisan and exponent being Dr. Auguste Kerckhoffs, professor of modern languages at the School of Higher Commercial Studies in Paris. From France it spread to all parts of the world. Three international Congresses were held, the third taking place at Paris in 1889. At that time there were 283 Volapük Clubs spread all over the world, 316 text-books had appeared, and there were some 30 periodicals appearing in Volapük or dealing with it.

The disappearance of Volapük was due largely to the internal dissensions of its partisans, some of whom, led by Dr. Kerckhoffs, wished to make it simpler and more adapted to the needs of commercial life.

These attempts at reform were, however, resisted by the learned originator. No doubt his system

was too complicated and intricate for the majority of people. Moreover, those who took an interest in the problem of an auxiliary international language were soon provided with the much simpler and more practical Esperanto.

The author of this language, Louis Lazarus Zamenhof, was born in 1859 at Bielostok, in what was then Russian Poland. Perceiving the racial and linguistic hostilities of his native country, as a young school student in Warsaw he already dreamed of a universal neutral language and of a universal brotherhood founded thereon. He graduated as a physician at Warsaw, but during the six years of his university course he worked constantly at his secret project. At first he thought of reviving Latin, or of constructing an *à priori* or philosophical language. It was the study of English, however, that first showed him what could be done by means of a simple grammar, and how stems of different origins could be utilised in the construction of a harmonious and self-contained language. In 1885 his work was complete, but it was only in 1887 that he found a publisher. In that year there appeared in Warsaw a Russian pamphlet describing "La Lingvo Internacia de la Doktoro Esperanto," The international language of Dr. "Hopeful." In 1900 there appeared the "Universala Vortaro de la Lingvo Internacia Esperanto," by L. Zamenhof. In this dictionary the equivalents were given in five languages. The pseudonym "Esperanto," adopted originally by Dr. Zamenhof, has been transferred to the name of the language. The progress of Esperanto was at first slow. But in 1898, when the French took the lead, expansion became rapid. The Marquis Louis de Beaufront became the leader of this movement. In 1914, when the war broke out, there were over a hundred Esperanto periodicals, some appearing in Esperanto only, others in Esperanto and a national tongue. In 1905 an international Convention or Congress was held at Boulogne. Since then twelve other international Congresses have been held, the thirteenth at Prague in 1921. As an international auxiliary language, Esperanto has had an unparalleled success. It has done more to spread the idea of the need for and the possibility of an auxiliary international language than any other project.

The fundamental ideas of Zamenhof were very largely those of Schleyer: a phonetic system, a regular method of pronunciation, a vocabulary of root-words drawn from the international treasury, an autonomous system of word-formation, and a perfectly regular grammar. In other words, an *à posteriori* synthetic language. But in practice the contrast was enormous. Zamenhof did not transform and distort his international roots as Schleyer did. He carried out the choice of international stems on a much broader basis. His grammar was enormously more simple and practical. The inflexional richness of the work of the learned and scholarly Schleyer disappeared, and together with it most of his *à priori* and arbitrary elements. Zamenhof's autonomous system of word-derivation by means of affixes of fixed and definite meanings, and by means of root-combinations, was immensely superior. The arbitrary characteristic endings corresponding to a classification of ideas, a relic in Volapük of the earlier *à priori* philosophical systems, disappeared in Zamenhof's language. The idea of using only monosyllabic roots was given up, and so the international appearance of these could be much better preserved.

In spite of many obvious and indeed glaring defects, Esperanto is undoubtedly, so far as numbers are concerned, the greatest and most successful linguistic experiment that the world has yet seen. Let us not criticise too severely the work of a man who was neither a great scholar nor a great professional philologist, but let us rather admire the splendid effort which he made. His work has been of the greatest service in demonstrating to an indifferent world the practical possibility of an auxiliary international language.

So great was the interest taken in this branch of science at the Paris Exhibition of 1900, that under the leadership of M. Leau, a French professor of mathematics, a number of men of science and delegates from learned societies were gathered together, and on January 17, 1901, the "*Delegation for the Adoption of an Auxiliary Language*" was founded. After a great deal of preliminary work on the subject, the matter was submitted, through the kind offices of the Imperial Academy of Sciences of Vienna, to the International Association of Academies, which on May 29, 1907, declared itself incompetent to deal with the question. The Delegation then proceeded itself to elect a special Committee to study the problem. This Committee embraced a number of distinguished authorities on science and linguistics, and included the two secretaries, Profs. Couturat and Leau. After eighteen sittings held at the Collège de France, the following decision was arrived at:

"None of the proposed languages can be adopted *in toto* and without modification. The Committee have decided to adopt in principle Esperanto, on account of its relative perfection and of the many and varied applications which have been made of it; *provided* that certain modifications be executed by the Permanent Commission, on the lines indicated by the conclusion of the Report of the Secretaries and by the project of Ido, if possible in agreement with the Esperantist Linguistic Committee."

It appeared later that the "project of Ido" was an anonymous pamphlet proposing a number of reforms in Esperanto, the real author of which was the Marquis de Beaufront, until that time the most eminent supporter of Esperanto in the world. Messrs. Couturat and Leau had made a most exhaustive and scholarly study of all known auxiliary languages, their labours being embodied in a very masterly book entitled "Histoire de la Langue Universelle," and also in another one entitled "Les Nouvelles Langues Internationales." Their Report to the Committee indicated very clearly the lines along which Esperanto could be improved.

As the Esperanto Linguistic Committee declined to collaborate, the Committee of the Delegation appointed a Permanent Commission to carry out the reforms which they had in view, and as they were unable to use the name Esperanto, the reformed Esperanto was called "Ido."

In its basic ideas Ido is a language of the same type as Esperanto. It is a great pity that all parties could not have combined at an early stage in the development of Ido. If I may be allowed a personal opinion, I will say that most, if not all of the Ido improvements appeal to me very strongly. If we are to choose a language of the Esperanto type, and if the choice lies only between Esperanto and Ido, I would choose Ido. I do not say this for any propagandist purposes, and I say it with a full appreciation of the splendid early work of Dr. Zamenhof. But at the same time I have an equally great admiration for the splendid later work of Prof. Couturat and his collaborators.

Ido, like Esperanto, has had a very great success, and has been very thoroughly developed. Many general and technical dictionaries have been worked out. Before the war there appeared ten or twelve periodicals dealing with, or written in, this language. The International Ido Academy has done very fine

work in bringing it to as high a state of perfection as possible. Very many Ido clubs and societies have been formed in all parts of the world, and already a very considerable literature exists. We may say that the Ido, like the Esperanto, movement, has done immense service in familiarising the world with the practicability of an international auxiliary language. Both these great linguistic experiments are of profound interest and importance.

I must now lead your thoughts away from Esperanto and Ido and back to the International Academy for a Universal Language, which was founded by the two international Volapük Congresses of 1887 and 1889. This Academy continued to exist, and set itself to the task of reforming Volapük. Very important and scholarly work was done by Mr. Rosenberger, a Russian engineer, and his collaborators (Rosenberger was Director of the Academy from 1893 to 1898). They produced a vocabulary of root-words based on the principle of maximum internationality. The greater part of these roots are common to at least four of the seven chief languages — German, English, French, Italian, Russian, Spanish, and Latin. Largely as a consequence of the inclusion of Latin, the result was an almost exclusively Neo-Latin vocabulary—one much more Romanic than that of Esperanto. A very simple grammar and a regular system of word-derivation by means of derivative affixes were introduced. But autonomous word formation was not allowed to exclude international derivatives.

Thus was produced about 1903 the Language "Idiom Neutral," the descendant of Volapük, though scarcely any trace of the parental features remained.

Idiom Neutral has not achieved the practical success of Esperanto and Ido. This may be because it came too late. It appeals to educated people more than Esperanto and Ido on account of its more homogeneous vocabulary, which is practically exclusively Romanic. But it has not been so fully developed as Esperanto and Ido. As a separate and independent project, it may be said to have disappeared with the death of Mr. Rosenberger in 1918.

A language of the Neo-Latin type, somewhat similar to Neutral Idiom, is the "Panroman" (or "Universal") of the German positivist and pacifist, Dr. H. Molenaar. Various attempts, such as those of Mr. Henderson and of Dr. Rosa, have been made to introduce a sort of simplified Latin. But the man who has defined most clearly the Neo-Latin principle, and who has worked not only the hardest in this field but has also grouped and organised many isolated workers of kindred views and affinities, is Dr. Giuseppe Peano, professor of mathematics in the university of Turin. In 1908 he became Director of the International Language Academy. In the "Discussiones" of that body he has published from year to year the work of himself and many collaborators. A very large amount of scholarly work has been done in the discovery of the international vocabulary common to Latin, Italian, French, English, and German. The result of this etymological study may be seen in Professor Peano's important "Vocabulario Commune," the second edition of which appeared in 1915. Following the indication given by Leibniz, Peano has built on an exclusively Neo-Latin basis so far as the main vocabulary is concerned, though modern words acquiring international usage may be accepted.

For many scientific purposes Peano's flexionless Latin is ready for use. He has himself employed it for many years in his own journal, *The Mathematical Review.*

The true solution of the problem may consist in selecting the most international roots according to the fashion of Peano, but also the most international affixes of derivation. With these natural elements, derivatives and compounds will then be formed according to simple and invariable rules. Thus the advantages of the Neo-Latin or Anglo-Latin vocabulary of stems will be combined with the regular and autonomous word-derivation of Ido. This is the view held by Prof. Guérard, who has just published a most valuable book entitled "A Short History of the International Language Movement" (Fisher Unwin, 1922). As Prof. Guérard points out, these two sets of fundamental ideas are embodied in the language project of M. Albert Michaux, entitled "Romanal."

Needless to say, Romanal is not the last word on the subject, nor is it free from debateable points. But it represents the combination of an "etymological Anglo-Latin" root vocabulary with regularity of word-derivation and simplicity of grammar.

In the preceding discussion I have endeavoured to give a very brief account of some of the principal efforts to solve the problem. The large amount of research work already done and the practical success of Esperanto and Ido prove that the problem is not an insoluble one. At first one might be inclined to think that the production of an international auxiliary language is a sort of parlour game, or at best a pure matter of caprice. Attentive study of the problem shows that this is quite a false view. Whatever may be the final solution, it is already clear that some of the fundamental principles have been elucidated. There *does* exist a science of synthetic linguistics, compounded of logic, psychology, and philology. It has been argued that the field hitherto traversed, at all events in the later systems, is too narrow; that the so-called international vocabularies are not really international and apply at best only to two groups of existing languages. What comfort, it is argued, can a word such as "amico" bring to the Basques, Finns, Hungarians, Turks, Japanese, Chinese, etc.? What special comfort, I would then ask, does the learning of English, French, German, Italian, Spanish, Dutch, Swedish, and Russian bring to a young Japanese gentleman? Are we then to go back to Sotos Ochando and bring comfort to nobody? I think not. But the objection is not one to be passed over lightly. It may be that the world will require more than one auxiliary language. Two, or even three, would be better than the necessity of having to learn a hundred living languages. Only time and prolonged study and investigation can settle questions of this order. The whole civilised world must collaborate in this investigation. There is plenty of time. We have been using an alphabet for, say, eight or ten thousand years at most, and as this planet is reckoned to be over a thousand million years old, it will probably continue to be habitable for some considerable time.

Meanwhile the problem is a very pressing one. Those who have to do with science, industry, and commerce feel this very acutely. Before the war I attended several international scientific congresses. On these occasions it was open to any one to speak in English, French, German, or Italian. When the language of the speaker or lecturer changed, one half of the audience usually adjourned to the refreshment bar. I could follow German, but when it was a case of Italian or Parisian French I also used to get thirsty. I am going to an international scientific congress in June of this year. The representatives of at least thirteen different nations will be present, and I expect at least four languages will be used. As the language of the country where the congress is to be held is not one of these, one ought really to know five languages. I am glad to say that the civilised world is at last beginning to take a real interest in this

problem. We may, indeed, say that, since the war, the whole question has entered on a new phase. Learned and scientific bodies of international influence and repute are beginning to study the matter seriously. The present organised movement in this direction may be considered as dating from the adoption, by the International Research Council at their meeting at Brussels in July 1919, of the following resolutions:

(*a*) That the International Research Council appoint a Committee to investigate and report to it the present status and possible outlook of the general problem of an international auxiliary language.

(*b*) That the Committee be authorised to co-operate in its studies with other organisations engaged in the same work, provided that nothing in these resolutions shall be interpreted as giving the Committee any authority to commit the Council to adhesion to or approval of any particular project.

This Committee is now at work. Its chairman is Dr. F. G. Cottrell, and its headquarters are at the offices of the National Research Council of the United States, 1701 Massachusetts Avenue, Washington, D.C. This Central Committee has already done an immense amount of work in securing the organisation of committees and working groups in the national academic organisations and educational institutions, and in co-ordinating this work and serving as a clearing-house for the exchange and distribution of information and plans. The first national response to the appointment of the International Committee was by the British Association for the Advancement of Science, which, at its Bournemouth Meeting in September 1919, appointed a Committee "to study the practicability of an International Language." This British Committee has been very active, and at the Edinburgh meeting of the British Association in September last, presented its report. Its conclusions may be summarised very briefly as follows:

(1) Latin is too difficult to serve as an international auxiliary language.

(2) The adoption of any modern national language would confer undue advantages and excite jealousy.

(3) Therefore an invented language is best. Esperanto and Ido are suitable; but the Committee is not prepared to decide between them.

The Committee is continuing to study the problem. The American Association for the Advancement of Science appointed a Committee in April 1921, and this Committee has presented a Report, which was accepted by the Council of the Association at Toronto on December 29 last. The Committee recommended that the American Association for the Advancement of Science:

(*a*) Recognises the need and timeliness of fundamental research on the scientific principles which must underlie the formation, standardisation, and introduction of an international auxiliary language, and recommends to its members and affiliated Societies that they give serious consideration to the general aspects of this problem as well as direct technical study and help in their own special fields wherever possible.

(*b*) Looks with approval upon the attempt now being made by the National Research Council and the American Council of Learned Societies to focus upon this subject the efforts of those scholars in this country best fitted for the task, and to transmit the results to the appropriate international bodies.

(*c*) Endorses the heretofore relatively neglected problem of an international auxiliary language as one deserving of support and encouragement.

(*d*) Continues its Committee on International Auxiliary Language, charging it with the furtherance of the objects above enumerated, and reporting progress made to the Association at its next meeting.

The American Council on Education, the American Classical League, the American Philological Association, and the National Research Council of America have also appointed Committees. Furthermore, the American Council of Learned Societies has authorised the appointment of delegates to confer with the Committee of the National Research Council. Thus the national American representatives of science and the humanities are uniting to study the problem.

Both the French and the Italian Associations for the Advancement of Science have also appointed Committees to examine and report on the international language question.

On September 13 last, the following resolution was presented to the Assembly of the League of Nations by delegates representing twelve States:

"The League of Nations is well aware of the Language difficulties that prevent a direct intercourse between the peoples, and of the urgent need of finding some practical means to remove this obstacle and help the good understanding of nations;

"Follows with interest the experiments of official teaching of the international language Esperanto in the public schools of some members of the League;

"Hopes to see that teaching made more general in the whole world, so that the children of all countries may know at least two languages, their mother tongue and an easy means of international communication;

"Asks the Secretary General to prepare for the next Assembly a Report on the results reached in this respect."

With regard to this motion, the special Committee dealing with the inclusion upon the Agenda of Motions submitted to the Assembly reported to that body on September 15 last, as follows:

"The above-mentioned delegates have proposed the introduction of Esperanto as an auxiliary international language into public schools, in order to facilitate direct intercourse between all nations throughout the world.

"The Committee are of opinion that this question, in which an ever-increasing number of great states are interested, should be attentively studied before it can be dealt with by the Assembly."

As a result of this, the secretariat of the League have been instructed to investigate the experiments already made and ascertain the actual results attained.

On November 20 last, some Swedish gentlemen interested in the question of an international language formed a Committee to promote this subject and to unite the various interests concerned. This Committee has brought the matter before the Swedish Parliament and has also addressed a request to the League of Nations.

From all this it will be evident that the existence of the problem, and the urgent necessity for its study and investigation, are now fully admitted and recognised by the learned, scientific, and political organisations of the highest national and international status. Before definite action can be taken by national governments, there must be, however, another period of prolonged and exhaustive linguistic research and experiment. This work must be, as we have every reason now to hope and expect, co-ordinated and supported internationally. Those who have laboured manfully in the past, and the many who have given their adherence to this or that special solution, must be prepared to co-operate without bias and without sorrow. The subordination of self and of the most dearly held, the most beloved possessions of the mind in the interest of intellectual advance and the common good of humanity is the spirit of true science.

The Properties of Powders.

CONSIDERABLE interest attaches, both on the scientific and on the technical side, to the study of powders which are sufficiently fine to differ markedly in their properties from massive crystals, while they are sufficiently coarse to differ equally widely from colloidal suspensions. One important property of powders, namely the caking of salts (a phenomenon which was responsible for the disastrous explosion at Oppau), was discussed at a joint meeting of the London Section of the Society of Chemical Industry and of the Faraday Society on March 1, 1920. This has now been followed up by a joint meeting of the Faraday Society and the Oil and Colour Chemists' Association, held at Burlington House on March 9 last, when the material presented was sufficiently abundant to call for an adjourned discussion on March 23.

The principal subject discussed was the grading of powders by elutriation, a process which has proved of great value to the geologist and to the agriculturist, as well as to the manufacturer of pigments and of food products where artificial grinding is required in order to produce minute subdivision.

(a) 4 mm. (b) 5 mm. (c) 6 mm. (d) 7 mm. (e) 8 mm. per sec.

FIG. 1.—Elutriation of Barytes. (× 50.)

The formal papers presented to the meeting were four in number. Prof. Lowry and Mr. L. P. MacHatton, in a paper on "The Grading of Powders by Elutriation," submitted a new series of experimental data as to the diameter of the particles of barytes and of quartz which are just lifted by a vertical current of water at velocities ranging from 4 to 8 mm. per second (Fig. 1). The data for barytes are more concordant than those for quartz, probably because the particles of barytes are, in the main, cleavage-fragments of fairly uniform shape, whilst in the case of quartz the natural conchoidal fracture produces much more irregular particles. In the case of barytes it was possible to show that the use of a vertical tube one inch in diameter lifts particles which are 5 per cent. smaller than when a half-inch tube is used; but the grading is also much more uniform as a result of the more uniform velocity of the water in the tube. The temperature-coefficient was also measured and shown to correspond with a decrease of 0·4 per cent. only in the diameter of the particles for each degree of rise of temperature; and an empirical relationship was deduced between the velocity of the water and the size of the grain of barytes lifted by it.

Prof. Boswell presented a paper on "The Separation of the Finer Constituents of Sedimentary Rocks," in which the geological applications of elutriation are described. One of the principal problems here is to devise a method of summarising the mechanical analysis of a sediment, containing particles of many different sizes, in such a way that the results can be expressed by means of one or two numbers. The use of a single number is impracticable, since in addition to the fineness of the material, its uniformity must be represented by a separate coefficient. A satisfactory solution appears to have been provided by Dr. H. A. Baker, who makes use of the term "equivalent grade" to express the average of the diameters of the particles, whilst a "grading factor" serves to express the deviation of the particles from the average. Prof. Boswell has had much experience in the practical application of elutriation, particularly in the mechanical analysis of the sands and rocks used in glass-making, and his notes on the difficulties and errors encountered in the process are of considerable value. Dr. J. W. French, who has made use of water-separation for the grading of emery and carborundum for use as polishing powders in grinding lenses, contributed to the same meeting a paper on "Abrasives and Polishing Powders for Glass."

Dr. R. S. Morrell, the president of the Oil and Colour Chemists' Association, opened the discussion, by emphasising the value of elutriation to colour-users, as a method of controlling the materials which they purchased from the pigment-makers and grinders.

The adjourned discussion was opened by Dr. C. A. Klein of the Brimsdown White Lead Company. While Prof. Lowry had been working with a range of sizes down to about 0·07 mm., Dr. Klein's work had dealt with grades in which this was more nearly the maximum than the minimum size of the particles; they therefore presented greater experimental difficulties, more particularly as a result of flocculation. In addition to describing a number of points in connection with the practical use of the elutriator, Dr. Klein stated that a specification had actually been put forward by a user of pigments who was calling for the supply of some hundreds of tons of a product in which the largest particles would have a diameter not exceeding 0·1 mm., whilst the average size of the particles was not to exceed 0·027 mm. This specification was being worked to and material conforming to it could be supplied.

Prof. Lowry then showed "A New Elutriator for Rapid Use," especially adapted for use in factories. The gravimetric determination of the residue of coarse particles is here replaced by a simple measurement of the height of the column of grit in a narrow tube, and tests can therefore be made even where the ordinary facilities of a chemical laboratory are not available. Lieut.-Col. J. V. Ramsden, of Shropshire Mines Ltd., stated (at the previous meeting) that with the help of this instrument he had been able, whilst using the same grinding plant, to reduce the residue in ground barytes from 6 per cent. to 0·5 per cent. Prof. Lowry added that since this instrument was introduced two years ago the relative merits of British and imported samples of ground barytes had been reversed completely, with the result that the finest products that he had tested recently were of British manufacture.

Mr. W. J. Palmer referred to the practical importance of fine grinding in the paint industry, both in the preparation of enamels and as a means of preventing the hard setting of paint in cans which were sent abroad or stored for some years before being used. Mr. Noel Heaton contradicted the general impression that the ball-mill tends to produce round particles, since when the glass was ground in this way, even to 0·003 or 0·004 mm. diameter, the particles when examined by the microscope had the normal appearance of broken glass and were not in the least degree rounded.

Dr. R. Lessing mentioned some applications of elutriation in connection with the fire-brick, coal and metallurgical industries. Its application to metallurgy was described by Mr. Holman in connection with tin slimes, where a loss of 10 to 15 per cent. was traced to the carrying away of very fine particles in a current of water.

Mr. Tate, of the Government Laboratory, referred to elutriation as a process of analysis in the separation of cocoa from husk in the ground product; a paper on this aspect of the subject was also submitted by Mr. R. Whymper of Messrs. Peek, Frean & Company.

Mr. B. A. Keen, of Rothamsted, criticised the method of elutriation as applied to the mechanical analysis of soils, largely on the ground that the shape of the particle was as important as the size in determining the velocity of water required to lift it. In dealing with very fine particles the simpler process of sedimentation was to be preferred.

Prof. Porter, the President of the Faraday Society, in closing the discussion, referred to centrifuging as a means of grading fine powders, and commented on the relationship which Prof. Lowry had put forward between velocity and grain-size. He also referred to the utility of the discussion and especially to the value of bringing together workers from different fields, who could present information which, although well known to one section of individuals, might not be known at all to other groups represented at the meeting.

The International Petroleum Commission.

AT the ninth annual General Meeting of the Institution of Petroleum Technologists, held on March 14, Prof. J. S. S. Brame delivered his presidential address, taking for his subject the proposals for the re-establishment of the International Petroleum Commission. International Petroleum Congresses were held in 1900, 1904, and 1908, and committees were appointed to establish methods of testing products. Little was actually achieved, and in 1909 an International Petroleum Commission of wider scope was established. The organisation of an English National Section was referred to the Institution of Petroleum Technologists by Engler and Ubbelohde, but the intended meeting of the Commission at Bucharest in 1914 was prevented by the outbreak of war.

At the first annual meeting of the Petroleum Products section of the Société de Chimie Industrielle at Paris in 1921, M. Schmitz suggested the reconstitution and endowment of this Commission to be centred at the University of Strasburg. He spoke somewhat bitterly of the Americans "profiting by the general disorganisation to seek to abandon the analytical methods previously decided upon, in favour of their own."

Prof. Brame expressed grave doubts as to the wisdom and the justice of M. Schmitz's address. He could not believe that the largest oil-producing country, which had created such splendid organisations as the Bureau of Mines and the American Society for Testing Materials, was likely to depart from the methods of oil analysis it had elaborated and adopted. He outlined the development of these Institutions and the standard methods of petroleum testing they had recommended, and spoke of the cordial relationship between the Standardisation Committee of the Institution of Petroleum Technologists and these American organisations, from which collaboration he hoped would result an agreed system of nomenclature and specifications of the greatest mutual advantage. Such agreement he considered of much greater value to the two countries having by far the largest interests in petroleum than could be gained by the reinstitution of an International Petroleum Commission.

Facilities for Foreign Students in American Colleges and Universities.

THE Bureau of Education of the Government of the United States have issued under the above title, as Bulletin No. 39 of 1920, a revised and enlarged edition of a valuable handbook by Dr. S. P. Capen first published in 1915. It presents in a concise and readily intelligible form a comprehensive survey of a subject concerning which few people in this country have more than a very fragmentary knowledge. After a brief account of the organisation of education of all grades and a historical summary of the college and university systems, the Bulletin gives a description of the parts and working of the typical university and draws a comparison between American and other educational institutions. Next follow particulars of the cost of living and travel, athletics, clubs, etc., and lists of institutions of collegiate or professional grade located in the principal metropolitan centres of higher education, namely, New York, Chicago, Philadelphia, St. Louis, Boston, Baltimore, San Francisco, New Orleans, and Washington. Forty-five pages are devoted to a detailed definition of the requirements of the College Entrance Examination Board, an organisation formed by some 30 colleges together with the principal associations of colleges and secondary schools, which holds examinations in almost every State and in several foreign countries, including Canada, England, and France.

Colleges (and the collegiate, or undergraduate, divisions of universities) have, we are informed, come by common consent to express their entrance requirements in terms of "units," a unit representing "a year's study in any subject in a secondary school, constituting approximately a quarter of a full year's work. A four-year secondary school curriculum (the normal preliminary to admission to a college) should be regarded as representing not more than 16 units of work." Accordingly the definition of requirements includes not only examination syllabuses but also outlines of secondary school courses of study. Accounts of some approved methods of instruction and typical time-tables are added. As pointed out in the article on America in the Universities Year-book, 1922, "a peculiarity of the American system of grading, both in secondary and in higher institutions, is the weight attached to the length of time spent under instruction, a degree being attainable by gradual accumulation of a specified number of 'credits' (certificates of definite periods of time spent successfully under instruction) which thus largely replace the examinations used in other countries for testing the student's capacity at various intervals."

More than half of the Bulletin is devoted to descriptions of 74 universities, colleges, and technical and professional schools which have already been frequented by foreign students or which give courses likely to prove of special interest to such students. The descriptions deal with courses, degrees, equipment, expenses, strength of staffs, number of students, number of foreign students, and miscellaneous items of special interest to foreign students. There are also statistical tables for 1918 relating to State universities and certain agricultural and mechanical colleges, schools of mines, and other technological schools, and a list of medical colleges rated as Class A by the council on medical education of the American Medical Association. A few copies of the Bulletin are available at the Universities Bureau, 50 Russell Square, and can be obtained on payment of 1*s*. 3*d*. to cover the price (15 cents) and postage.

University and Educational Intelligence.

BIRMINGHAM.—The University has received from the Trustees of the James Watt Memorial Fund the sum of 5000*l*. towards the establishment of a Chair of Research in Mechanical Science to be known as "The James Watt Chair."

Mr. James Couper Brash has been appointed professor of anatomy, to fill the vacancy occasioned by the lamented death of Prof. Peter Thompson. Mr. Brash held the position of acting professor during the leave of absence granted to the late professor. The appointment of Mr. Cyril A. Raison as part-time assistant in anatomy has been confirmed by the Council.

CAMBRIDGE.—The family of the late Mr. J. M. Dodds have founded at Peterhouse a studentship to be known as the J. M. Dodds studentship for the promotion of advanced study or research in the subjects of mathematics or physics. The first election will be held in June 1923.

LONDON.—Application for grants from the Dixon Fund for assisting scientific investigations must be made before May 15 to the Academic Registrar, University of London, South Kensington, S.W.7.

Prof. J. A. Fleming has been compelled, on account of illness, to cancel all engagements for the present, and will consequently be unable to deliver the course of lectures on "Modern Improvements in Telephony" at University College which had been announced to begin on April 26. It is hoped that Prof. Fleming will be able to deliver the course in October.

MANCHESTER.—Prof. J. W. Smith has intimated his intention to resign, as from the end of the present session, the Chair of Systematic Surgery, which he has held since 1911. The following appointments have been made in the Faculty of Technology: Lecturers in Mechanical Engineering, R. M. Anderson, H. Threlfall; Lecturer in Spinning, J. Winterbottom; Demonstrators in Chemical Technology, W. H. Brindley, W. Hubball, W. H. Kelly, Esther Levin, and J. D. Mounfield; Demonstrator in Metallurgy, G. Mohn.

SHEFFIELD.—A course of five lectures on coal will be given in the Department of Applied Science on April 27 and successive Thursdays at 5·30 P.M. The first lecture, to be delivered by Dr. Marie Stopes, will deal with the palæobotanical aspects of the constitution of coal; the second, by Mr. F. S. Sinnatt, with the preparation of coal for the market; the third, by Dr. R. Lessing, with the carbonisation of coal; the fourth, by Mr. M. Wynter Blyth, with the manufacture of crude benzole; and the fifth, by Prof. J. W. Cobb, with the nitrogen in coal and its recovery as ammonia.

THE Education and the Parliamentary Committees of the British Science Guild have had under their careful consideration the recommendations of the Geddes Committee so far as these affect education. Their report, which has received the approval of the executive committee of the Guild, embodies certain proposals with the object of effecting reduction in expenditure where it can be shown to be without detriment to the legitimate purposes of educational expenditure. They desire to suggest one or two changes in such expenditure whereby economy in time and money can be achieved. It is essential that financial control shall be the duty of both State and local education authorities. The first consideration is, how much can be raised annually, both locally and Imperially, in respect of education and its ancillary needs, and next, how it can best be allocated in accordance with the legitimate claims of each department. The second essential is that the education committee to which the administration of education is delegated by the local authority shall be held responsible for the use of the funds. The present method of allotment of State moneys, namely 50 per cent. of the permitted local expenditure, is not peculiar to education but prevails in other State departments, and is under review with regard to its continuance. It is alleged that it multiplies unduly public officials, increases expense both of time and money, and that it is subversive of the principle of local control. The suggestion in the Geddes Committee's Report that the lower limit of compulsory age should be raised from five to six is commended, but with the proviso that it shall be accompanied by the institution of nursery schools for young children under the age of six years. A modification of the present scholarship system is suggested whereby only children of exceptional capacity, and whose parents cannot pay for their further education, shall be eligible for free places and for maintenance grants, available in schools of widely varying type. It is recommended that the practice of duplication of inspectorships should be abolished. One set of inspectors would be found quite efficient. If these reforms were carried out, much of the time now taken by unnecessary clerical work on the part of the highly paid staff of teachers and officials would be saved, and their efforts be devoted to more fruitful educational results.

Calendar of Industrial Pioneers.

April 13, 1742. John Lofting died.—Born in Holland about 1659, Lofting removed to London in 1688, where he became well known as a successful inventor and maker of fire-engines.

April 13, 1874. James Bogardus died.—An American inventor, Bogardus made improvements in clocks, constructed a delicate engraving machine, invented the dry gas meter, a deep-sea sounding machine, and a dynamometer, while his plan for manufacturing postage stamps was accepted by the British Government.

April 13, 1894. William Haywood died.—For forty-eight years Haywood was chief engineer to the Commissioners of Sewers in London, and he was also the constructor of the Holborn Viaduct. He introduced the use of asphalt for city roads.

April 15, 1908. J. Wigham Richardson died.—The founder of an important shipbuilding firm on the Tyne, Richardson contributed much to the advancement of the building of large mercantile vessels and served as President of the North-East Coast Institution of Shipbuilders and Engineers.

April 17, 1899. Sir James Wright died.—The successor of Thomas Lloyd as Engineer-in-Chief of the Navy, Wright held this position from 1872 to 1887. Trained at Dundee, he became an assistant in Woolwich Dockyard in 1845, and was transferred to the Admiralty two years later. He was intimately connected with the adoption of the compound engine, twin screws, forced draught, high pressures, and the triple expansion engine.

April 18, 1916. Sir John Durston died.—One of the few fellows of the Royal School of Naval Architecture and Marine Engineering, Durston entered the Royal Navy in 1866 as an assistant engineer and rose to be the Engineer-in-Chief. Taking office in 1889, at a time of great difficulty, Durston held office till 1907, and to him was mainly due the introduction into the Navy of the water-tube boiler and the Parsons steam turbine.

April 18, 1920. Rudolph Messel died.—Educated at the University of Tübingen, where he studied chemistry under Strecker, Messel after the Franco-Prussian War came to England, where he joined Squire. He worked out a method for the manufacture of fuming sulphuric acid, and with Squire erected important chemical works at Silvertown.

April 19, 1904. Sir Clement Le Neve Foster died.—From the Royal School of Mines Foster passed to the Mining Academy at Freiburg, and in 1860 joined the Geological Survey. He was an inspector of mines from 1872 to 1901, and in 1890 succeeded Warington Smyth as professor of mining in the Royal College of Science. His important work on "Ore and Stone Mining" appeared in 1894. In 1903 he was knighted.

April 19, 1914. Alfred Noble died.—After serving in the American Civil War, Noble studied civil engineering in the University of Michigan, and became an eminent constructor of canals, docks, and bridges. He was a member of various commissions appointed to report on the feasibility of a ship canal across the Isthmus of Panama, and he played an important part in solving some of the engineering problems connected with the Panama Canal. He served as President of the American Society of Civil Engineers, and in 1910 received the John Fritz medal for "notable achievements as a Civil Engineer."

E. C. S.

Societies and Academies.

London.

Royal Society, March 30.—Sir Charles Sherrington, president, in the chair.—The late W. G. **Ridewood**: Observations on the skull in fœtal specimens of whales of the genera Megaptera and Balænoptera. Five fœtal skulls were described. The presence of an interparietal bone in some whales, and the meeting of the parietals in a median suture in others, is of little use in taxonomy. Syncondyly is associated with suppression of the atlanto-epistropheal joint. There is no separate foramen for the hypoglossal nerve. The periotic bone shows no separate centres of ossification, but a diffuse endochondral granular deposit. The orbitosphenoid ossifies independently of the presphenoid. In whales there is no "external pterygoid plate" of alisphenoidal origin; the alisphenoid is the ossified ala temporalis. The growth of the malleus and of the tympanic bone, and the relations of the great bulla to the primary annulus tympanicus, were described.—W. L. **Balls**: Further observations on cell-wall structure as seen in cotton hairs. The daily growth rings consist of large numbers of fibrils, spirally arranged, with frequent reversals of the direction of the spirals. This arrangement is predetermined for the secondary cellulose of the growth rings by the initial pattern laid down in the primary wall. The individual fibrils have a cross-sectional area of the order of 0·05 square microns. Some of the evidence suggests stereo-isomerism in cellulose.—L. T. **Hogben** and F. R. **Winton**: The pigmentary effector system. I. Re-action of frog's melanophores to pituitary extracts. The posterior lobe of the pituitary gland contains a specific stimulant which, if injected into the frog, brings about a condition of general and complete expansion of the dermal melanophores. A minute dose induces a darkening of the skin readily visible to the naked eye. The pituitary melanophore stimulant is not destroyed by pepsin or boiling. It is rapidly destroyed by trypsin but not so quickly by acid hydrolysis. After cocaine, curare, atropine and apocodeine it still evokes its characteristic response, and therefore acts directly upon the melanophores. The results confirm the endocrine significance of the condition of general pigmental contraction found by Allen and others to follow removal of the pituitary gland in tadpoles.—Agnes **Arber**: On the development and morphology of the leaves of palms. The leaf-stalk is the basal or proximal region of the true petiole while the "fan" or "feather" limb is a modification of the distal region of the true petiole. The complex plication of the limb arises through the development of a series of invaginations penetrating the leaf-stalk tissue between the bundles. The "ligule" and "dorsal scale" of the fan-palms represent adaxial and abaxial distal margins of the uninvaginated proximal region of the petiole. The palm leaf, as a whole, is a petiolar phyllode with a pseudo-lamina.—H. E. **Roaf**: The acidity of muscle during maintained contraction. Records of electrical changes by a manganese dioxide electrode in combination with a calomel electrode show that: (*a*) In a veratrinised muscle the acidity remains as well as the tension. (*b*) In decerebrate rigidity reflex inhibition is accompanied by a decrease in acidity. Thus acidity and tension are related and a single mechanism is sufficient to account for both tetanus and tone.

Geological Society, March 22.—Prof. A. C. Seward, president, in the chair.—Sir Charles J. **Holmes**: Leonardo da Vinci as a geologist. Leonardo was the

first to have a large and accurate conception of the causes underlying the physical configuration of the earth. His studies of aqueous erosion, the formation of alluvial plains, the process of fossilisation, and the nature of stratification, led him to a logical conviction of the immensity of geological time, far in advance of the dogmatic thought of his age, and exposed himself to the charge of atheism. Caution compelled him to work in isolation, and to keep his results concealed. He had no scientific instruments, no correspondents to furnish him with observations on geological conditions elsewhere; yet his grasp of the physical history of the portions of Italy which he had visited was sound, and entirely in accord with modern knowledge. Leonardo left a record of his discoveries in his paintings, generally in the backgrounds. There are found pictures of the primeval world as he imagined it, when seas and lakes ran up to the foot of the mountains, to be slowly displaced and silted up by the detritus which the rain carried down from the summits.

Brussels.

Royal Academy of Belgium, March 4.—M. A. Lameere in the chair.—C. **Servais**: The geometry of the tetrahedron, Pt. 4. The cubic surface of Cayley.—P. **Martens**: The cycle of the somatic chromosome in *Paris quadrifolia*.

Diary of Societies.

FRIDAY, April 14.

Malacological Society (at Linnean Society).

WEDNESDAY, April 19.

Royal Meteorological Society, at 5.—W. T. Russell: The Relationship between Rainfall and Temperature as shown by the Correlation Coefficient.—R. A. Fisher: The Correlation of Weekly Rainfall.—Prof. S. Chapman and Miss E. Falshaw: The Lunar Atmospheric Tide at Aberdeen, 1869–1919.

Royal Microscopical Society, at 8.—C. Beck: The Photometry of a Bull's-Eye Lens for Illuminating Microscopic Objects.—Dr. S. C. Harland and J. H. Denham: The Use of the Microscope in Cotton Research.—Dr. R. S. Ludford: The Morphology and Physiology of the Nucleolus.—H. Sutcliffe: The Use of the Microscope in the Rubber Industry.

THURSDAY, April 20.

London Mathematical Society (at Royal Astronomical Society), at 5.

Institution of Mining and Metallurgy (at Geological Society), at 5.30.

Child-Study Society (at Royal Sanitary Institute), at 6.

Institute of Metals (London Section) (Annual General Meeting at Shaftesbury Hotel, Great St. Andrew Street, W.C.1), at 8.—H. Moore: The Ball Hardness Test.

FRIDAY, April 21.

Institute of Transport (at Royal Society of Arts), at 5.—J. K. Bruce: The Operation of a Large Tramway Undertaking, with reference to Capacity and Cost under given Conditions.

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British Dyestuffs Industry.

THOSE who scrutinise with anxious attention the progress of the British dyestuffs industry are aware that the stage now reached is one surrounded by dangers of a character more economic than technical. The Dyestuffs (Importation) Act has been in operation during fifteen months, and at the outset of this period two main factors contributed to smooth administration. As a consequence of the Sankey judgment, this country had been flooded with German dyes in quantity and variety amply sufficient to supply the normal needs of one year's good trade; concurrently, every branch of industry was facing an abnormal depression, which reflected itself in a greatly diminished consumption of dyestuffs. It followed that the principal problems arising in regard to licensing imports were questions affecting identity or equivalence of the domestic dyes when competing with foreign products.

The period under review has been one of steady progress by the British factories, and an opportunity to visualise their achievement was offered lately by an imposing exhibition of synthetic colouring matters at the British Industries Fair. Still more recently, Brig.-Gen. Sir William Alexander, Chairman of the British Dyestuffs Corporation, invited a large gathering of press representatives to review the circumstances in which the renascence of this industry took place, and to apprehend the nationally fundamental need of maintaining it. There is grave public danger in the present risk that, as the connection between dyestuffs and explosives recedes into the background of the public mind, the more permanently important features of this industry will sink into oblivion. Failure to realise how closely the chemical industry is linked with the general manufacturing activities of the country springs from the apathy with which chemistry, particularly the organic branch, has been regarded in Great Britain, and Sir William Alexander has rendered a public service in emphasising the fact that research in the dyestuff industry creates and maintains a very highly trained body of organic chemists who, in an emergency, are qualified to apply themselves to technical national problems, whether these relate to peace or war.

This admonition is a timely one, because a variety of circumstances indicate growth of opposition to the principle of the Dyestuffs (Importation) Act. At the moment, although great strides have been made by the research departments of the British factories towards improving the quality and diminishing the cost of their colours, prices are still in many cases higher than can be viewed with equanimity by the dyer or calico-printer, and advantage is being taken of this drawback by those who, from motives of gain, or in disregard of national interests, seek the repeal of the Act. Owing to countless variations of detail in the application of dyestuffs to textiles, it is difficult to secure trustworthy information respecting the percentage of cost borne by a colouring matter in the finished product; in some cases it is trifling, in others it may be substantial, and in the general scramble to reduce cost of production, it is natural for those colour-users whose range of vision is not wide to pounce upon the dye-costs and demand relief. Meanwhile, the opportunity now in the hands of German factories owing to currency depreciation is one which they have not been slow to use, but it would be foolish to imagine that any mercy will be shown by Germany to British colour-users if once the domestic industry is allowed to perish.

Happily there are colour-users who look beyond the needs of the moment, and to such it is evident that the effort now being made to shatter the industry in adolescence must, in the interest of the whole community, be faced and overcome. If this country is not allowed to establish a dye-making industry, incalculable damage will ultimately accrue to the textile trade. In the first place, the dyer will suffer in becoming a spoon-fed vassal of the German factories; he will grow less and less capable of exercising his craft intelligently, and of devising novel applications to textile fabrics. This will diminish the attraction which British products offer to foreign markets, and in that degree curtail the operations of the textile manufacturer, who will be further handicapped by exorbitant prices for German dyes. Finally, if this, the principal industrial incentive to the pursuit of applied organic chemistry be permitted to languish, this country deliberately excludes itself from the immediate benefits,

and the potential profits, of all future revolutionary discoveries comparable with that which, in 1856, led to the displacement of natural colouring matters by the products of coal-tar chemistry.

Sexual Life and Marriage among Primitive Mankind.

The History of Human Marriage. By Prof. E. Westermarck. Fifth edition, rewritten. Vol. 1, pp. xxiv + 571. Vol. 2, pp. xii + 595. Vol. 3, pp. viii + 587. (London: Macmillan and Co., Ltd., 1921.) Three Volumes. 84*s*. net.

COMPARATIVE sociology, in many of its branches, started with very simple and homely concepts, and now, after a career of imaginative and somewhat sensational spinning of hypotheses, we find it returning in its latest developments to the position of common sense. The subject of family and marriage, of their origins and evolution, epitomises such a typical course of sociological speculation. In the views about the human family, there was first the uncritical assumption that the family was the nucleus of human society; that monogamous marriage has been the prototype of all varieties of sex union; that law, authority and government are all derived from patriarchal power; that the State, the Tribe, economic co-operation and all other forms of social association have gradually grown out of the small group of blood relatives, issued from one married couple, and governed by the father. This theory satisfied common sense, supplied an easily imaginable course of natural development, and was in agreement with all the unquestioned authorities, from the Bible to Aristotle.

But some sixty years ago, among the many revolutions in scientific thinking and method, the family theory of society seemed to have received its death-blow. The independent researches of Bachofen, Morgan and MacLennan seemed to prove beyond doubt, by the study of survivals and ethnographic phenomena, by methods of linguistics, comparative study and antiquarian reconstruction, that the whole conception of primeval monogamous marriage and early human family was nothing but a myth. Primitive humanity, they said, lived in loosely organised hordes, in which an almost complete lack of sexual regulation, a state of promiscuity, was the usage and law. This, the authors of this school concluded, can be seen from many survivals, from the analysis of classificatory systems of relationship, and from the prevalence of matrilineal kinship and matriarchate. Thus, instead of the primitive family we have a horde; instead of marriage, promiscuity; instead of paternal right, the sole influence of the mother and of her relatives over the children. Some of the leaders of this school constructed a number of successive stages of sexual evolution through which humanity was supposed to have passed. Starting from promiscuity, mankind went through group marriage, then the so-called consanguineous family or Punalua, then polygamy, till, in the highest civilisations, monogamous marriage was reached as the final product of development. Under this scheme of speculations, the history of human marriage reads like a sensational and somewhat scandalous novel, starting from a confused but interesting initial tangle, redeeming its unseemly course by a moral *dénouement*, and leading, as all proper novels should, to marriage, in which "they lived happily ever after."

After the first triumphs of this theory were over, there came, however, a reaction. The earliest and most important criticism of these theories arose out of the very effort to maintain them.

In the middle eighties of last century, a young and then inexperienced Finnish student of anthropology started to add his contribution to the views of Bachofen and Morgan. In the course of his work, however, the arguments for the new and then fashionable theories began to crumple in his hands, and indeed to turn into the very opposite of their initial shape. These studies, in short, led to the first publication by Prof. Westermarck in 1891 of his "History of Human Marriage," in which the author maintained that monogamous marriage is a primeval human institution, and that it is rooted in the individual family; that matriarchate has not been a universal stage of human development; that group marriage never existed, still less promiscuity, and that the whole problem must be approached from the biological and psychological point of view, and though with an exhaustive, yet with a critical application of ethnological evidence. The book with its theories arrested at once the attention both of all the specialists and of a wider public, and it has survived these thirty years, to be reborn in 1922 in an amplified fifth edition of threefold the original size and manifold its original value. For since then Prof. Westermarck has developed not only his methods of inductive inference by writing another book of wider scope and at least equal importance, "Origin and Development of Moral Ideas," but he has also acquired a first-hand knowledge of savage races by years of intensive ethnographic field work in Morocco, work which has produced already numerous and most valuable records.

Where does the problem stand now? First of all, the contest is not ended yet, and divergencies of opinion obtain on some fundamental points, while controversy

has not lost much of its uncompromising tone. But the issues have narrowed down somewhat. There is no longer a question of accepting the naïve theory which regarded family as a kind of universal germ of all social evolution; nor, on the other hand, does any competent sociologist take very seriously the fifteen successive stages of promiscuity, group marriage, Punalua marriage, etc. Prof. Westermarck and his school do not maintain the rigidly patriarchal theory, and they are fully aware of the importance of matrilineal descent, of the maternal uncle's authority, and of the various kinship anomalies connected with matriliny. The classificatory terms of relationship are, moreover, not considered by Prof. Westermarck as mere terms of address, but as important indications of status.

The representatives of the opposite school had also to make some concessions, though rather reluctantly and grudgingly. Scarcely any one nowadays would be so irreverent towards our ape-like ancestors and ancestresses as to suspect them of living in a general state of promiscuity. But there is still a formidable list of names, among them some of the most eminent representatives of modern anthropology, quoted by Prof. Westermarck (vol. 1, p. 103 *n.*), who consider primitive promiscuity as "not improbable," "plausible," "by no means untenable," and use this hypothesis constantly as a skeleton-key to open all questions of sex. Group marriage is still, though somewhat faint-heartedly, affirmed to have existed, and even some savages are forced to live up to their evil reputation—in the speculations and bare assertions of some writers. The Punalua family leads an even more shadowy existence, merging into a combined polyandry and polygamy. The most tenacious survival of the Bachofen-Morgan-MacLennan theories seems to be the kinship terms, themselves a most fecund breeding-place for all kinds of survival theories.

Thus Prof. Westermarck in this new edition is not altogether relieved of the necessity of dealing with the hypothesis of promiscuity, and in chapters iii.-ix. he examines the various classes of evidence adduced in its favour. There is a number of statements affirming directly the existence of promiscuous conditions among this or that tribe or people. Some of them come from garrulous and credulous writers of antiquity and have to be discarded as pure fables; others, from modern travellers, equal them in untrustworthiness and futility. On this point no one will certainly controvert the author when he says "that it would be difficult to find a more untrustworthy collection of statements." The investigation then turns to that remarkable group of ethnological facts—*Jus Primae Noctis*, licence of festive and religious character, prenuptial and orgiastic sexual intercourse—in which the powerful instinct of sex, curbed and fettered by social regulations, takes, in its own time, revenge on man by dragging him down to the level of a beast. Prof. Westermarck fully admits the importance and extent of these phenomena; his survey indeed shows the extreme range and the often astounding perversity of these deviations. But he declines resolutely to see in any of these facts a survival of pristine promiscuity, for in all cases the facts reveal most powerful motive forces, and can be attributed to definite psychological and social causes. The theory of survival is moreover irreconcilable with the fact that we find side by side with licentious tribes, savages who maintain strict chastity; that some of the most primitive ones are virtuous, whilst the most luxuriant growth of licence is found in more advanced communities; that, finally, civilisation instead of abolishing these phenomena only modifies them.

The chapters on customary and regulated sexual licence are full of penetrating suggestions, and the facts, skilfully marshalled, are made to speak for themselves, and will supply a lasting compendium for students of sexual psychology. But what appears most valuable in this, not less than in other parts of the work, are the methods and implications of the argument. Prof. Westermarck has an abhorrence of the now fashionable tendency of explaining the whole by its part, the essential by the irrelevant, the known by the unknown. He refuses to construct out of meagre and insufficient evidence a vast, hypothetical building, through the narrow windows of which we would have to gaze upon reality, and see only as much of it as they allow. The obvious, common-sense and essentially scientific way of proceeding is to get firm hold of the fundamental aspects of human nature—in this case the psychology of sex, the laws of primitive human grouping, the typical beliefs and sentiments of savage people—and, in the light of this, to analyse each fact as we meet it. But to construct the unverifiable hypotheses of primitive promiscuity and interpret facts in terms of figments is, as Prof. Westermarck shows, a method which leads nowhere and lures us from the true scientific path.

Some of the other chapters of Prof. Westermarck's book give us another approach to the psychology of sex and to the theory of human marriage. Sex is a most powerful instinct—one of the modern schools of psychology tries to derive from it almost all mental process and sociological crystallisation. However this may be, there is no doubt that masculine jealousy (chap. ix.), sexual modesty (chap. xii.), female coyness (chap. xiv.), the mechanism of sexual attraction (chap. xv. and xvi.) and of courtship (chap. xiii.)—all these forces and conditions made it necessary that even in the most primitive human aggregates there should

exist powerful means of regulating, suppressing and directing this instinct. There is no doubt that all the psychological forces of human sexual passion, as well as the conditions of primitive life, must have tended to produce a primeval habit of individual pairing. We have to imagine a man and a woman forming more or less permanent unions which lasted until well after the birth of the offspring. This, Prof. Westermarck develops in the first chapter of his work. A union between man and wife, based on personal affection springing out of sexual attachment, based on economic conditions, on mutual services, but above all on a common relation to the children, such a union is the origin of the human family. This primeval habit, according to the "tendency of habits to become rules of conduct," develops with time into the institution of family and marriage, and "marriage is rooted in the family, rather than the family in marriage."

Marriage, indeed, right through the book, is conceived in the correct sociological manner, that is, as an institution based on complex social conditions. The greatest mistake of the writers of the opposing school—a mistake which, I think, they have not corrected even in the most recent publications—is their identification of marriage with sexual appropriation. Nor is this pitfall easy to avoid. For us, in our own society, the exclusiveness of sexual rights is the very essence of marriage. Hence we think of marriage in terms of individual sexual appropriation, and project this concept into native societies. When we find, therefore, groups of people living in sexual communism, as undoubtedly happens among a few tribes within a limited compass, we have a tendency at once to jump to conclusions about "group marriage."

To the majority of savages, however, sexual appropriation is by no means the main aspect of marriage. To take one example, there are the Trobriand Islanders, studied by the present writer, who live in the greatest sexual laxity, are matrilineal, and possess an institution which is probably the nearest approach to "group marriage" that exists or could ever have existed. Indeed, it resembles it much more, I think, than does the celebrated Pirrauru of the Dieri in Central Australia. These natives satisfy their sexual inclinations through all forms of licence, regulated and irregular, and then settle down to marry, decidedly not only or even mainly to possess a partner in sex, but chiefly out of personal attachment, in order to set up a household with its economic advantages, and last, not least, to rear children. The institution of individual marriage and family among them is based on several other foundations besides sex, though sex—naturally—enters into it.

Space does not allow me to follow Prof. Westermarck into his dialectic contests with the most eminent of his contemporaries—with Sir James Frazer and Dr. Rivers about the kinship terms (chap. vi.); with Sir James Frazer and Mr. Hartland on matriliny (chap. viii.); and with all of them, as well as Spencer and Gillen, on group marriage (chap. xxvi.). In all these arguments we find the same extensive use of ethnological material, the same breadth of view and moderation of doctrine, above all, the same sound method of explaining the detail by its *whole*, the superstructure by its foundation. In the treatment of kinship and matriliny, too little concession is perhaps made to the important theories of Sir James Frazer and Mr. Hartland, whose views, unquestionably correct, that ignorance of paternity is universal and primitive among savages, Prof. Westermarck cannot accept. Nor can he see perhaps sufficiently clearly the enormous influence of this savage ignorance on primitive ideas of kinship. As Sir James Frazer says:

"Fatherhood to a Central Australian savage is a very different thing from fatherhood to a civilized European. To the European father it means that he has begotten a child on a woman; to the Central Australian father it means that the child is the offspring of a woman with whom he has a right to cohabit. . . . To the European mind the tie between a father and his child is physical; to the Central Australian it is social" ("Totemism and Exogamy," i. p. 236). The distinction between a physiological and a social conception of kinship is indeed essential. But, on the whole, Prof. Westermarck's views do not diverge so much from those of Frazer's, who, on the other hand, occupies a moderate position among the supporters of the opposite theories.

Prof. Westermarck's explanation of exogamy, and of the prohibition of incest—which I think will come to be considered as a model of sociological construction, and which remarkably enough seems to find favour with no one—can only be mentioned here. The excellent chapters on marriage rites (chaps. xxiv.-xxvi.); the analysis of what could be called the numeric varieties of marriage, monogamy and polygamy (chaps. xxvii.-xxviii.); polyandry (xxix.-xxx.); duration of marriage (xxxii.-xxxiii.), stand somewhat apart from the main argument of the book. Each division is a monograph, a *Corpus Inscriptionum Matrimonialium*, a treatise in itself.

The book is and will remain an inexhaustible fount of information, a lasting contribution towards the clearing up of some of the most obscure aspects of human evolution, and it marks an epoch in the development of sociological method and reasoning.

B. Malinowski.

Some Chemical Treatises.

(1) *Fundamental Principles of Organic Chemistry.* By Prof. C. Moureu. Authorised Translation from the Sixth French Edition by W. T. K. Braunholtz. Pp. xviii+399. (London: G. Bell and Sons, Ltd., 1921.) 12*s.* 6*d.* net.

(2) *A Text-book of Inorganic Chemistry.* Edited by Dr. J. N. Friend. Vol. 9, part 2, *Iron and its Compounds.* By Dr. J. N. Friend. (Griffin's Scientific Text-books.) Pp. xxv+265. (London: Charles Griffin and Co., Ltd., 1921.) 18*s.*

(3) *A Dictionary of Chemical Solubilities. Inorganic.* First edition by Dr. A. M. Comey. Second edition, enlarged and revised, by Dr. A. M. Comey and Prof. Dorothy A. Hahn. Pp. xviii+1141. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1921.) 72*s.* net.

(1) THE wealth of material comprehended by organic chemistry constitutes a very real and formidable difficulty to the instructor in that branch of science. It is calculated that up to the present time more than two hundred thousand organic substances have been discovered and described, and the number is being steadily added to week after week. It is obviously impossible for any lecturer on the subject to deal with more than a very small fraction of this *materia chemica.* Nor is there any reason why he should. Fifty or sixty years ago organic chemistry was scarcely taught in our universities, and, even when taught, was treated in a lifeless, unsystematic manner. Students, far from being attracted towards it, were frankly bored by the uninteresting recapitulation of empirical facts, methods of preparation, and physical properties, which usually made up the substance of the teacher's prelections. All this, however, is now changed. The enormous accretion of fact has been brought under law and order. The whole has been collated, and, for the most part, reduced to fundamental principles. The view of the village is no longer obscured by the houses.

It is with these fundamental principles alone, based upon the co-ordination of facts, or groups of facts, that the teacher of organic chemistry to-day can concern himself, if he would seek to convey any adequate conception of the field of study occupied by that department of science. In the hands of a capable, well-informed man, gifted with philosophic insight and endowed with the faculty of exposition, tuition in organic chemistry can be made a most fascinating occupation. To supplement the teacher's work in the lecture-room, however, the students should be provided with a well-ordered text-book, dealing with the principles concerned. Such a book is that under review. In its original form it has already been noticed in these columns. Since that time it has gone through many editions, and has found its way beyond French university circles. The sixth French edition has now been translated into English by Mr. Walter T. K. Braunholtz, and appears with an introduction from Prof. Sir William J. Pope, of the University of Cambridge.

We heartily commend Prof. Moureu's book to all—both teachers and taught—to whom the philosophic aspects of organic chemistry appeal. No more interesting work on the subject has appeared within recent years. It is written with that clarity, logical sense, faculty of arrangement, and sense of proportion which are such striking characteristics of French scientific literature. We trust that in its English dress it will have a reception commensurate with its great merits.

(2) As was mentioned in a former notice in NATURE of vol. 9 of Dr. Newton Friend's great work on inorganic chemistry, it has been found necessary to treat the subject of iron in a separate part of that volume, on account of the great importance of the metal and the voluminous literature which has grown round it. This has been found so great that it has been deemed desirable to subdivide the volume still further. The part now under review treats of the chemistry of iron and its compounds, its metallurgy being relegated to part 3, which is being dealt with by the editor in collaboration with Mr. W. H. Hatfield.

The general plan of part 2 is similar to that of the preceding volumes. It opens with an account of the early history of iron as a metal, beginning with the use of meteoric iron by prehistoric man, and of smelted iron by the Egyptians, Ethiopians, Assyrians, and Israelites. According to authorities quoted by Dr. Friend, India acquired her knowledge of iron from Babylon. The famous pillar at Delhi is far from being so old as is usually surmised. It dates back probably to about A.D. 300. Greece was the first country in Europe to use iron—probably about 1400 B.C. It was known in Britain about a century before the Roman invasion, when, as mentioned by Cæsar, it was used in the form of bars for currency. Specimens of these bars are in the British Museum and in the Worcester Museum. Chap. 2 is concerned with the mineralogy of iron, and gives an account of its ores and other ferruginous minerals, many of which, of course, are of no importance as sources of the metal. It is noteworthy that the mean percentages of ferrous and ferric oxides contained in American igneous rocks are considerably less than in similar British rocks. Chap. 3 treats of the preparation and properties of pure iron, the passivity of iron, its action as a catalyst, etc. A short section on its atomic weight is contributed by Mr.

Little. The final value 55·84 is sufficiently far from a whole number to suggest the existence of isotopes, for there is every reason to believe that this value is well established. In view of Dr. Aston's work, and the resuscitation of Prout's hypothesis, it will be interesting to learn how the difference from the integer is to be accounted for. Chap. 4 deals with the important subject of the corrosion of iron, of which the editor has made a special study. It is, however, remarkable, in spite of the large amount of work which has already been done on this subject, how much remains to be ascertained. The remaining chapters, five in number, deal with the general properties of iron salts, of its compounds with hydrogen and the halogens, and with the elements of Groups VI., V., IV., and III. of the Periodic Table. The whole concludes with a chapter on the detection and estimation of iron.

As in the case of the entire work, a special feature is a wealth of bibliographical reference. Practically every statement can be verified by reference to the original source of information. This, of course, adds greatly to the value of the treatise as a compendium, but it is naturally not of much service to the student without access to a well-found library. There is probably no single library in London in which all the books thus referred to could be found.

A new feature in the work is the inclusion of a table giving a list of important journals and periodicals dealing with chemical matters, with the dates of issue of their several volumes, from the year 1800 down to 1919. It was compiled by Mr. Clifford, the librarian of the Chemical Society, and occupies some eight pages of the book. Its value to the book itself is not very apparent, since the date of publication in the case of any particular reference is invariably given in the footnote. The table has no special appropriateness to the volume under review; its proper place would be either at the beginning or the end of the completed work.

(3) The "Dictionary of Chemical Solubilities," by Drs. A. M. Comey and Dorothy A. Hahn, is a revised and enlarged edition of a work by the first-named author which appeared in 1895, and which, in its turn, followed the well-known "Dictionary of Solubilities" compiled in 1864 by Prof. F. H. Storer on a plan indicated so far back as 1731 by Peter Shaw. Storer's book is long since out of print, and no attempt has been made to bring it up to date and to reissue it. During the quarter of a century which has elapsed since the first edition of Dr. Comey's work a large amount of additional matter relating to the solubilities of inorganic substances, with which the book is alone concerned, has made its appearance. This has been carefully brought together by Dr. Dorothy A. Hahn, of Mount Holyoke College, and forms the material upon which the present edition is based. It constitutes a volume of 1140 closely printed pages, and its subject-matter has been brought down to 1916. Its printing and publication have been delayed by circumstances arising out of the war.

In a work of this kind easy reference is of primary importance, and opinions may differ as to the best arrangement to adopt. The one used is practically alphabetical, but it will be obvious that such a scheme leads to occasional anomalies, which could be obviated only by elaborate cross-referencing, thereby adding considerably to the bulk of the volume. In the case of discrepant statements by different observers, no attempt at a critical selection has been made, which we think detracts from the value and authority of the work. A careful examination of the original papers and of the methods and apparatus employed would have enabled a satisfactory judgment to be reached, and thereby obviated much unnecessary printing. Methods of determining the solubilities of gases, for example, have been improved greatly since Bunsen's time, and many of his estimations have been superseded by more accurate observations. It serves no useful purpose to retain them, and indeed only confuses the searcher, who is not in a position to discriminate between the several observers. The compilers may rightly say they have done their best to deal with the enormous mass of material they have collected, but they can scarcely have escaped the conviction that much of the numerical data rests upon a very insecure experimental basis. The fact is, it is only within quite recent times that methods of estimating solubilities have reached the necessary precision, and that sources of error hitherto overlooked have been obviated.

In spite, however, of these difficulties and imperfections, the present work is the most comprehensive compilation on the subject which has yet appeared in any language, and a word of commendation is due to Dr. Hahn for the patience, care, and assiduity with which she has collected the vast amount of material with which she has had to deal.

Formal and Philosophical Aspects of Logic.

Logic. By W. E. Johnson. Part 1. Pp. xl+255. 16*s*. net. Part 2. Demonstrative Inference: Deductive and Inductive. Pp. xx+258. 14*s*. net. (Cambridge: At the University Press, 1921, 1922.)

A LOGICIAN is a person who takes infinite pains to solve problems which present no manner of difficulty to ordinary mortals. This may be, and no doubt is, because ordinary mortals live and die unconscious of

the inconsistencies of general theory. The logician is therefore of necessity a very serious person, and to suspect a twinkle in his eye when he is propounding his problem is to undermine his authority. But there is another reason why he must be serious. If he would make formal logic a distinctive science he must walk warily between the devil and the deep sea, for on the one hand he has to beware of falling into pure matters of grammar, the use and misuse of the parts of speech, and on the other hand he has to avoid the abyss of metaphysics. Indeed if one were to take a pencil and score through everything in a treatise on logic which really depends on an intelligent understanding and use of grammar and everything also which depends on a disputable metaphysical theory, it would be difficult to be sure that anything would remain. There used to be a subject, taught at universities, called rhetoric, and many chairs of it still survive, but it would puzzle any one now to say definitely what a professor of rhetoric is expected to teach. It looks as though logic may some day and very soon be in a similar case.

Two parts of Mr. Johnson's logic are yet to come. The two parts before us are exceedingly well written. Every sentence is a model of clearness and lucidity. However puzzled the reader may be when he discovers the sort of problems he is invited to discuss, if he yields to the spell and plays the game, he will find a certain philosophical interest which will engage his attention throughout.

The influence of "Principia Mathematica" is very much in evidence; probably without that work few of the problems here dealt with would have had any *raison d'être*, even if they had been discovered to exist. Thus Mr. Johnson makes a very important point of a division he proposes between propositions, verbally identical, into primary and secondary. Truth and falsity, he tells us, can be predicated of propositions in quite different senses according as they are one or the other. "Some fairies are malevolent" if it is a primary proposition is necessarily false because fairies do not exist. But if it applies to "descriptions" of fairies then, as descriptions exist, it is true, and it is a secondary proposition. Similarly, in the chapter on negation we are asked to consider propositions such as these opposites. "An integer between 3 and 4 is prime" and "An integer between 3 and 4 is composite." Here we are told that though one is contradictory of the other, neither is true because both have a non-existent subject. This is in keeping with the endless interest Mr. Russell discovered in the question of the truth or falsity of the proposition "The present King of France is bald." All one can say is that if any nonsensical content becomes a proposition once it is invested with the propositional form, then logic had better be abandoned to those for whom games are the serious business of life.

The author's main purpose, however, seems to be a more exact classification and an improved terminology. He thinks the serious objection urged against the correspondence theory of truth can be got rid of by substituting the terms "accordance" and "discordance" for correspondence and non-correspondence. We may admit that the new terms are in a sense non-committal, but is that a gain? Another proposal is concerned with the subject of Modality. It is to substitute "certified and uncertified," for the term problematic, and to distinguish the certified into formally certified and experientially certified, apparently in order to have technical terms in logic for the old philosophical distinction between truths of reason and matters of fact. Also for "necessary" he would substitute two pairs of terms, nomic and contingent, and, epistemic and constitutive. The peculiar character of proper names he proposes to designate by the term "ostensive." In all this we seem to be hearing the echo of Mr. Russell's complaint that we shall never make progress in science until we construct and use a scientific language.

Perhaps the most novel thing in the logical theory expounded in Part 1 is the Paradoxes of Implication. The "typical paradox" is certainly not what we ordinarily designate by that term, and the author is aware that his use requires justification. A paradox in the ordinary meaning is the affirmation of a proposition the actual terms of which include its negation, as for example, "Whoso loses his life shall save it." The essence of the paradox is that despite its apparent contradiction in form it contains defensible philosophic truth. The logical paradox here discussed is very different. You may be led by implication (p implies q) technically correct, to the form "if p then q" where p may stand for the proposition $2+3=7$ and q for the proposition "it will rain to-morrow," then you have the paradox. At this point no doubt the ordinary person would lose interest, but if you are a logician it is here the problem becomes engrossing.

One very interesting discussion, also in Part 1, is the famous Leibnizian principle of "the identity of indiscernibles." No one can fail to see that metaphysically the principle is an essential part of the concept of substance, yet logically there seems no way of keeping this in view, and the author reaches the conclusion—which is quite correct on his principles—that it seems to him in any case to have no logical justification whatever.

In Part 2 there is a distinct increase in the philosophical interest. The difference between the aspect of a problem to the philosopher and to the logician

becomes more marked, and the author is sometimes at pains to show that the doctrine he is discussing has reference purely to formal logic. The subjects dealt with are of the first importance. For example, the relation of logic to mathematics is discussed with very penetrating criticism, and Mr. Johnson finds that he differs from Mr. Russell on the fundamental concept of this relation. The mathematical function is for Mr. Russell a description derivable from the propositional function of logic, whereas Mr. Johnson argues that the propositional function of logic is nothing but a particular case of the mathematical. In discussing functional deduction generally Mr. Johnson says "the essential purpose of symbolism is to economise the exercise of thought; and thus symbolic methods are worse than useless in studying the philosophy of symbolism or of mathematics in particular."

There are many new distinctions discovered and new terms proposed. In particular we are to distinguish two direct principles of inference, the applicative and the implicative, each with a counter principle; we are to add to the distinctions of magnitudes as extensive and intensive an intermediate form termed distensive; and, more important still, we are to distinguish between the question of the absoluteness or relativity of space and time and the question of their substantival or adjectival nature. But perhaps the most astonishing distinction of all (is it a new discovery?) is that of the syllogism and the antilogism. The antilogism like the syllogism has its four modes A E I O, and, in the illustration given, simply by altering the mode we can present the argument for new realism, the argument for Hume's scepticism, or the argument for Kant's formalism. Verily formal logic may be in the way of becoming a formidable weapon in the hands of a philosophical controversialist.

Terrestrial Magnetism in the Antarctic.

British ("Terra Nova") Antarctic Expedition, 1910–1913: *Terrestrial Magnetism.* By Dr. C. Chree. Pp. xii + 548 + 60 plates. (London: Harrison and Sons, Ltd., 1921.)

BOTH of Captain Scott's Antarctic expeditions included observations of the earth's magnetism in their programme of scientific work, and the experience gained in the first was turned to good use in the second. The two magnetic observers were Dr. G. C. Simpson and Mr. C. S. Wright, to whom is due the credit for the fine work done at the base station. A noteworthy improvement was made by Dr. Simpson in the method of time-marking on the magnetograph sheets, which has since been adopted in some regular magnetic observatories. The magnetographs were in operation for nearly two years (February 1911 to November 1912); at the beginning of the second year Dr. Simpson was recalled to his official duties in India. Besides the continuous record of the three magnetic elements at Cape Evans, a considerable number of absolute measurements were made by the naval officers of the expedition, both in the "field" (principally at Cape Adare) and at sea.

The important task of preparing a report describing and discussing all these observations was entrusted, as in the case of the former expedition, to Dr. Chree. This report has just been issued, in the form of a large quarto volume, prepared and published at the cost of the fund raised by public subscription in memory of Captain Scott and his companions. Apart from the observations taken by the naval officers, which were mainly reduced by themselves, not only the discussion but also the reduction of the observations has been executed by or under the supervision of Dr. Chree; the measurement of the magnetograph curves, the reduction of the measurements, and the discussion of the important but somewhat tedious instrumental questions which arise, involve an amount of labour which can be but little appreciated by those unfamiliar with the subject. Of the 548 pages of letterpress, about one hundred are devoted to the tables, giving hourly values of the three magnetic elements, while about one-quarter of the volume is occupied by a valuable set of plates, mainly reproducing actual magnetograph records, from the Antarctic or elsewhere.

Following out his characteristic plan, Dr. Chree has kept strictly to the comparison and discussion of facts as facts; the echoes of theoretical controversy can be at most remotely perceived, and speculations as to the cause of the phenomena reviewed with such painstaking care are expressly deprecated by the author. Whether or not it is best at all times to restrict the discussion within these severe limits of certainty, few can disagree with the adoption of the course in preparing a report of this kind. In the spirit with which he has approached the task Dr. Chree has shown, not only his devotion to his chosen science, but also his personal appreciation of the work done by those who obtained the observations, or made the observations possible, in the inhospitable regions of the Antarctic.

The general plan of the volume is similar to that of the one dealing with the earlier expedition. The first six chapters describe the reductions which lead to the monthly mean values, non-cyclic changes, diurnal inequalities (with Fourier coefficients), daily range, and daily maxima and minima of the magnetic

elements; the rest of the discussion is on more individual and less standard lines. Dr. Chree devotes great attention to the important subject of the magnetic "activity"—its variations from day to day and from hour to hour, and its connection with other magnetic characteristics. He finds, for instance, that the remarkable differences existing between the Antarctic diurnal magnetic variations on quiet and on disturbed days are by no means merely proportionately intensified forms of the corresponding differences in temperate latitudes. Again, he investigates the tendency for a given state of magnetic activity to recur after twenty-seven days, a phenomenon long ago suggested by Broun and others, and independently established and brought into prominence more recently by Mr. Maunder. Dr. Chree uses his own admirable method based on daily character figures, and finds the tendency to be as clearly shown by the Antarctic as by the Kew records. The variation of the magnetic activity throughout the day, and even over short periods of an hour or so, has also been studied, the latter with the aid of the quick-speed records arranged to be taken simultaneously for "term hours" at the Antarctic and at many co-operating observatories. While these records have proved useful for the purpose named, Dr. Chree expresses doubt as to the desirability of including this arrangement in the programme of future polar expeditions.

Another subject discussed in much detail is magnetic disturbance of various kinds, including "sudden commencements," whether followed by a magnetic storm or not, large disturbances (studied from Antarctic and other records) and short-period disturbances. Some cases of the repetitions of disturbances at about the same hour on successive or adjacent days, such as were first noticed by Señor Capello in the Lisbon curves, were found in the Antarctic records, and are illustrated; it is to be regretted that the corresponding curves from other observatories were not obtained for these as well as for the larger disturbances discussed.

With the co-operation of Mr. C. S. Wright, an interesting chapter on the relation between auroræ and magnetic disturbance is included. In this chapter various definite numerical criteria are applied to test the view generally held that there is a close connection between the two phenomena. It is so difficult, on account of daylight, clouds and moonlight, to get records of auroræ at all comparable with the magnetic records in continuity or completeness that it requires some ingenuity to devise satisfactory numerical tests of the connection; Dr. Chree's tables succeed in confirming it, as they show that 41 per cent. of the "first-class" auroræ observed were associated with days of character-figure 2 (connoting a magnetically disturbed day), while no single aurora of the fourth class was so associated. It appears also that auroræ are probably rarely, if ever, totally absent, even at the times most quiet magnetically.

In order to utilise the results to the best advantage, Dr. Chree has not shrunk from entering upon enormous pieces of arithmetical computation, and the preparation of this report has been an enterprise which even those naturally most inclined towards numerical work might have shirked. The volume is necessarily restricted in its appeal, but magneticians will everywhere be grateful to Dr. Chree for the clear and accurate way in which he has ascertained and presented so many of the leading facts regarding the magnetic phenomena of the Antarctic.

The Analysis of Drugs.

The Chemistry and Analysis of Drugs and Medicines. By H. C. Fuller. Pp. ix+1072. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 55*s*. net.

THE number of drugs in use at the present day runs into thousands, and each of them is a component of one or more, often many more, "medicines." The materials used as drugs include such diverse products as plants the constituents of which are unknown, elementary substances such as colloidal copper and sulphur, and complex but well-defined compounds like "salvarsan." To prepare a comprehensive account of the analysis of drugs and medicines is therefore a difficult task, and one may doubt Mr. Fuller's wisdom, but not his courage, in tackling it.

He has produced a book which is inclusive rather than useful, and is unnecessarily large, owing to faults in the arrangement of matter and to needless repetition; thus the assay of the principal crude drugs is described in chap. 2, and drugs which contain alkaloids or glucosides are discussed again in the chapters devoted to these constituents, with the result that the determination of morphine in opium is dealt with on pp. 53-60, and a second set of processes for this operation is given on pp. 211-13, a cross-reference being provided in neither case.

Many authors inadvertently repeat themselves, but it must be unusual to find such a case as that of saligenin in this book, which is described twice, each time under a central heading in heavy type on the same page (553), and a third time on p. 787; the headings are different each time, viz. "ortho-oxybenzyl alcohol," "salicyl alcohol," and "saligenin," but a chemist, with his daily experience of vagaries in nomenclature, should be prepared for such pitfalls.

In writing names of chemicals the conventional plan of writing all the parts of a name together—*e.g.* "acetylbenzoylaconine"—is sometimes adopted; at other times they are separated by hyphens, as in "Para-hydroxy-phenyl-ethylamine"; but occasionally they are disconnected completely, as in "Benzoyl Ecgonin."

The defects of the book are, unfortunately, not limited to matters of arrangement and nomenclature. Thus the jaborandi alkaloids are wrongly grouped with the derivatives of pyridine, and the attributions in some other groups are doubtful, whilst the alkaloids of physostigma and anhalonium should not be described as "of unknown composition." In the section relating to solanaceous alkaloids the information is given that "hyoscin, which was formerly reported as a naturally occurring constituent of henbane, has now been virtually relegated to oblivion." In spite of this it is resurrected four pages further on in the curious form "Scopolamin, hydrobromate (Hyosin)," and is apparently reconsigned to oblivion, since it fails to appear in the section devoted to scopolamine. Though *Hyoscyamus muticus* has probably been the chief source of atropine for more than twenty years, the only reference to it is as follows: "*Hyoscyamus muticus* is often offered for import as true *H. niger*." Cotarnine, in spite of its importance in medicine, is not mentioned, though each of the minor alkaloids of opium has a paragraph to itself.

The resin of podophyllum is described as containing both podophyllotoxin and picropodophyllin, whereas only the former is present, the latter being an isomeride formed by the action of alkalis. The section on Indian gum may include all that is known about this commodity in the United States, but it is misleading as regards the sources and character of this gum as it appears in European markets. In the portion relating to resins no attempt is made to deal critically with the numerous doubtful data published regarding the chemistry of these products; thus the formula $C_{20}H_{40}O_2$ is assigned to abietic acid, though it is described as containing hydroxyl, and is presumably a hydroxy-acid, while sandaracolic acid is mentioned as a constituent of sandarac, though the author of this acid withdrew it years ago.

Enough has perhaps been said to show that Mr. Fuller's book should be used with discretion. As it deals with nearly everything, including chewing gum, that has been used or can be regarded as a drug, and gives references copiously, it is at least a useful guide to the all too voluminous literature on the analysis of these products, though even in this respect it would be improved if the index were more complete and always strictly alphabetical. T. A. H.

South African and Indian Floras.

(1) *An Introduction to the Flora of Natal and Zululand.* By Prof. J. W. Bews. Pp. vi+248. (Pietermaritzburg: City Printing Works; London: Wheldon and Wesley, Ltd., 1921.) 15*s*.

(2) *The Flora of the Nilgiri and Pulney Hill-Tops.* By Prof. P. F. Fyson. Vol. 3. Pp. xviii+581. (Madras: Government Press, 1920.) 15 rupees 6 annas.

(1) THE volume by Dr. Bews, who is professor of botany in the Natal University College, Pietermaritzburg, was written mainly for the purpose of assisting students of plant ecology and those engaged in botanical survey work in Natal. The flora of that country received for many years the devoted attention of the late Dr. J. Medley Wood, who published among several other works a "Handbook to the Flora of Natal" in 1907, and a "Revised List of the Flora of Natal" in 1908, to the latter of which two supplements were issued. The Handbook is now out of print, and the Revised List is not easy to procure, while both are incomplete. Dr. Bews's work, therefore, supplies a need and will be welcomed. It contains 478 species of flowering plants that are not included in Wood's Revised List. Like Wood's Handbook it gives keys to the families and genera, short descriptions of the former, and enumerations of the species, with a few words on their distribution and here and there a native name; the Cryptogams are excluded entirely.

A very important omission from both Dr. Wood's Handbook and Dr. Bews's Flora is some means for the identification of the species. We realise that to have provided keys to the species would have increased the size of the volumes very considerably, but it would have made them infinitely more useful. Some of the Natal genera are rich in species; Panicum has 35, Schizoglossum 41, Indigofera 44, Crassula 49, Senecio 84, while Helichrysum has as many as 92. With the best of keys it is difficult to determine the specific name of a plant belonging to any large genus, but Dr. Bews affords no help at all in the matter.

While Dr. Bews's book will no doubt be of service to those for whom it was chiefly intended, it does not go far enough. Much had already been done on the plants of Natal, and it might reasonably have been thought that the time had come when a work of more general usefulness could have been produced. It may be mentioned that Dr. Bews has arranged the families in his book according to Engler and Prantl's system, and that he has followed the practice observed by zoologists generally and by certain botanists of using a small initial letter for all specific names.

(2) Volumes 1 and 2 of Prof. Fyson's work were published in 1915, and were reviewed in Nature, vol. 96 (February 3, 1916), p. 615. These dealt with the flowering plants found above an elevation of 6500 feet around the hill-stations of Ootacamund, Kotagiri, and Kodaikanal. The present volume is supplementary, and includes the plants of the country around Coonoor above an elevation of 5000 feet.

The numerous outline drawings are an important feature in this volume as well as in the preceding; they certainly add considerably to the usefulness of the work, though, as they are full-page size, they have rendered it rather bulky and expensive. Notwithstanding that the text is in large, much leaded type it fills only 154 of the 599 pages in vol. 3; the other pages are used for the illustrations. These might have been reduced in size and the text might have been in smaller, less spaced type. By these means the matter in the three volumes could have been compressed into one. An admirable model might have been found in the late Colonel Sir Henry Collett's "Flora Simlensis." In Prof. Fyson's Flora we have another instance of the use of a small initial letter for all specific names. Whether this method of dealing with such names is advisable or not seems to be a matter of opinion; it has recently received some attention in the *Journal of Botany* (1921, pp. 159, 295-296).

Some additions and emendations in the volume under notice have been necessitated by the publication of Mr. J. S. Gamble's "Flora of the Presidency of Madras," of which the fourth part, carrying the work as far as the beginning of the Ebenaceae, appeared last August—too recent, therefore, for Prof. Fyson to have derived any assistance from it. He has been able to use Mr. Gamble's work only as far as the end of the Caprifoliaceae. It is probable, therefore, that the families from the Rubiaceae to the end will need some revisional treatment by Prof. Fyson, in order to bring his work into agreement with one that will be recognised for a long time to come as the authoritative Flora of Madras.

Science of Industrial Psychology

The Psychology of Industry. By Dr. J. Drever. Pp. xi+148. (London: Methuen and Co., Ltd., 1921.) 5*s*. net.

Industrial Fatigue and Efficiency. By Dr. H. M. Vernon. (Efficiency Books.) Pp. viii+264. (London: G. Routledge and Sons, Ltd., 1921.) 12*s*. 6*d*. net.

Two entirely different methods of approaching the science of industrial psychology are represented by the two volumes under notice. Dr. Drever's book is an attempt to cover the whole field of industrial psychology, and to accomplish such a task in a book of 148 pages must lay itself open to the charge of being somewhat superficial. He devotes a short chapter to each of the sub-divisions of the science, and quotes, in a not too critical spirit, certain well-known experiments which have been carried out. These examples are mostly taken from the writings of American efficiency engineers, and, interesting as they may be, they are not sufficient to form the foundation of a whole science. They must be submitted to a much more critical examination than Dr. Drever gives them if they are to form even part of the subject-matter of the science at all.

Dr. Vernon's book is of a very different type. Its object is not to write an introduction to a science which at present is so young that any such attempt must concern itself mostly with saying what can be accomplished, rather than what has already been done. His book is an attempt to deal with one aspect of the science and concerns itself more with facts than theories, and for this reason alone is far more scientific than Dr. Drever's book. In his preface Dr. Vernon says, "I have not attempted to discuss scientific management for I have no first-hand knowledge of it, and, moreover, the subject is so large a one that it needs independent treatment. For similar reasons I have not attempted to deal with Vocational Selection in industry." This passage is really the keynote to the whole book, for although the author quotes copiously from the works of other writers in the same field, yet his main argument depends on the first-hand information which he and his colleagues have collected from the various factories they have visited. Throughout the reader feels himself in touch with reality rather than in the somewhat theoretic atmosphere prevailing in Dr. Drever's book.

It is true that Dr. Drever's object is somewhat different from that of Dr. Vernon, for he tells us that the book was written primarily to awake interest in the ordinary man, and so help to spread knowledge of the service psychology can render to industry. Even so it may be doubted whether it is wise to spread knowledge in the way Dr. Drever has done. Those who are working in this field of applied science have two great practical difficulties with which to contend. One is the ignorance or antipathy of the ordinary man as to the possibility that physiology or psychology can render any appreciable services to the problems of industry, and the other is that he sometimes expects great results with comparatively little effort on the part of the scientific worker. Dr. Drever's book undoubtedly does much to remove the first difficulty, but in so doing it does a great deal to increase the second.

A book that devotes a chapter of fourteen pages to intelligence tests, and then gives in an appendix a foot-rule for intelligence testing, is bound to give the impression that any one with a certain degree of intelligence but without any special knowledge is in a position to apply such tests with fruitful results. Any such impression is erroneous in the extreme, and pays little respect to the psychologists who are experimenting in this field of research and are trying to overcome scientifically some of the difficulties inherent in the subject, which are either not mentioned or passed over so lightly by Dr. Drever.

The fundamental difference between these two books is that the author of one is mainly interested in industrial psychology from the point of view of the lecturer; while the main interest of the author of the other is that of the research worker. Industrial psychology has a long way to go before it can offer much scope for those who wish to lecture profitably about its principles, for most of these have to be discovered by the research worker and tested in various fields before they can claim to rank as truly scientific. It is because Dr. Vernon has attempted this that his book marks a definite advance in the science and should be read by all who are interested in the human side of industry either from the practical or the scientific point of view.

Glacial Climates.

Das Klima des Eiszeitalters. By Prof. Dr. R. Spitaler. Pp. iv + 138. (Prag: from the author, Smichow, 379. 1921.) 65K.

Dr Felix Oswald (Nature, vol. lxxv. p. 197) performed a remarkable feat when he printed his "Treatise on the Geology of Armenia" on a hand-press at Beeston in 1905. Prof. Rudolf Spitaler has reverted further, and has issued his work on glacial climates in a written script. The reproduction of this by lithography secures a uniformity that was not always possible among the ancients. He thus shows us a way out of the apparent *impasse* that has threatened scientific publication. The lodging in suitable libraries of, say, a hundred copies of a quarto memoir such as this would go far in the dissemination of ideas, and the process lends itself to tabular matter, freely used by Prof. Spitaler, and also to much delicacy of illustration. Authors in the days of imperial Rome were not dissatisfied with a manuscript mode of publication. The monumental "Naturalis Historia" of the elder Pliny, in thirty-seven books, gained a handsome circulation, and the author was engaged on a supplement—how well we know those supplements!—in the tragic year of 79. The genial Martial directs a would-be borrower to the shop of Attractus opposite Cæsar's forum, in the certainty that a copy of his latest poems could be bought there for five denarii. Allowing for the exchange, Prof. Spitaler asks little more, and we must remember that Roman publishers had the advantage of slave-labour.

In the beautiful script of his amanuensis, Prof. Spitaler supports the astronomical explanation of the climatic changes that produce or abrogate an ice-age. He divides the globe into zones of latitude, and shows how each would be affected by the variation of the perihelion position of the earth, combined with variation in the obliquity of the ecliptic. He lays stress on the distribution of land and water within the zones; climate is greatly affected by "continentality" and "oceanity." This, however (p. 29), does not account for the higher average temperature in January as against July at the equator, which is attributable to the occurrence of perihelion when winter reigns in the northern hemisphere.

A maximum excentricity of the orbit and a high obliquity of the ecliptic provide extreme conditions and promote glaciation; but Prof. Spitaler contends that even in these circumstances there need not be a reversal of the climate of each hemisphere every 10,500 years. He urges (p. 111) that a glacial climate, when promoted in the north, may affect the equator and still more the south, so that simultaneous glaciation over the whole earth, as postulated by A. Penck, is possible. Cool summers and mild winters (p. 94) favour snowfall, while hot summers and very cold winters are unfavourable. The maximum of the last warm period for the northern hemisphere (p. 57), when the summer took place in perihelion, is held to have occurred about 8500 years ago, an epoch that coincides presumably with the rapid melting back of the northern ice. The author (p. 131) looks forward to a continuance of a warm period, controlled by the excentricity, for nearly 500,000 years, when a great ice-age will again begin to affect the earth, unless tectonic changes intervene, such as have no doubt acted in the past. The Permian ice-age (p. 137) may be referred to the greater coolness of the large sea-area lying to the north of Gondwana Land, at an epoch of high excentricity, high obliquity of the ecliptic, with perihelion, as now, in the winter of the northern hemisphere.

In view of recent progress in physics, many geologists will prefer the hypothesis of variations in solar radiation as a possible explanation of great climatic changes; but this will not lessen their interest in Prof. Spitaler's detailed calculations.

G. A. J. C.

Our Bookshelf.

Capita Zoologica. Verhandelingen op Systematisch-Zoologisch Gebied. Onder Redactie van Prof. Dr. E. D. Van Oort. Deel I, Aflevering 1, *Nouvelles Recherches sur les Nématodes libres terricoles de la Hollande.* Par Dr. J. G. De Man. Pp. 62+14 plates. 10 guilders. Deel I, Aflevering 2, *Studien über Rhizostomeen mit Besonderer Berücksichtigung der Fauna des Malaiischen Archipels nebst einer Revision des Systems.* Von Dr. Gustav Stiasny. Pp. viii+176+5 plates. ('s Gravenhage: Martinus Nijhoff, 1921.) 16 guilders.

In these days of drastic economy it is becoming ever more difficult to find means for the publication of scientific work, especially when it has little or no direct bearing upon utilitarian problems. The systematic zoologist in particular has to content himself as a rule with as little as possible in the way of paper, letterpress, and illustrations, and it will probably be a long time before we see again in this country a series of zoological monographs comparable with that which embodies the results of the *Challenger* Expedition. Other countries, however, appear to be somewhat less embarrassed as to ways and means, and we are glad to welcome the appearance of a new Dutch periodical entitled *Capita Zoologica*, under the editorship of Prof. Dr. E. D. van Oort, Director of the State Museum of Natural History at Leiden. This publication will consist of a series of large quarto memoirs on systematic zoology, which will be issued separately as complete works as occasion requires. The first two are already published, dealing respectively with the free-living Terricolous Nematodes of Holland, by Dr. J. G. De Man, and with the Rhizostomatous Medusæ, by Dr. Gustav Stiasny. Both memoirs are fairly copiously, though by no means extravagantly, illustrated, and they form solid and valuable contributions to our knowledge of the groups with which they deal.

A. D.

Benzol: Its Recovery, Rectification, and Uses. By S. E. Whitehead. With an Introductory Note by the Rt. Hon. Lord Moulton. (The *Gas World* Series.) Pp. xiv+209. (London: Benn Brothers, Ltd., 1920.) Price 12*s.* 6*d.* net.

During the war the gas industry received a great impetus from the increasing demand for benzol and toluol for military requirements, and methods of recovery and production were adopted on a scale which was little appreciated at the time. One result of this was to pave the way for the foundation of a far greater benzol industry in this country than was previously existent, and the present volume has been written as a guide to the principles and practices engendered.

The text is most thorough, and while essentially practical, it does not ignore theoretical criteria cognate to the technicalities of the subject. The book is built up of exhaustive discussions of the recovery of benzol from gas, its rectification, and the uses to which it and the derivative products may be put. Probably the most interesting sections are those dealing with dyes, explosives, and the use of benzol as a motor fuel, which, although in the former connections modestly regarded by the author as summaries, are none the less useful and comprehensive. It is obviously important that, in view of this country's dependence on foreign resources of petroleum as a motor fuel, every effort should be made to ease the position by the establishment of a vast benzol industry, and in this effort the utmost encouragement should be given to those engaged in coal-gas production; the present volume is a valuable contribution to this end, and both for educational and technical purposes merits a wide circulation. H. B. Milner.

The Analysis of Mind. By Bertrand Russell. (Library of Philosophy.) Pp. 310. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Company, 1921.) 16*s.* net.

The title of Mr. Russell's book may raise expectations that it is an exposition or development of his philosophical theory. It cannot, however, take rank with his great works. It is a course of lectures, to all appearance a verbatim report, which has been subjected to the very minimum of revision. It is brimming over with casual witty remarks which pass well with an audience, but will not bear reflection. The lectures show Mr. Russell under the influence of two comparatively recent popular movements in philosophy and psychology, both of which seem to have attracted him powerfully, and neither to have convinced him completely, namely, William James's Neutral Monism and Prof. J. B. Watson's Behaviourism. One lecture deals at some length with the question, "Does Consciousness exist?" The answer reminds one of the famous pronouncement that Shakespeare's plays were not written by Shakespeare but by some one else of the same name. It is easy enough to argue that consciousness does not exist, but then there is something we are talking about when we affirm its non-existence, and it is difficult to find any other name for it. In regard to Behaviourism Mr. Russell thinks it a beautiful theory and an ideal method, but then—there are images, and the theory cannot account for them.

(1) *Aspects of Plant Life, with Special Reference to the British Flora.* By R. L. Praeger. (Nature Lover's Series.) Pp. 208. (London: S.P.C.K.; New York: The Macmillan Company, 1921.) 6*s.* net.
(2) *Mountain and Moorland.* By Prof. J. A. Thomson. (Nature Lover's Series.) Pp. 176. (London: S.P.C.K., 1921.) 6*s.* net.

There are many educated persons who are conscious that they miss much of the beauty and interest of the world around them through lack of knowledge and of the seeing eye that knowledge alone can give. To all such these two small volumes published by the S.P.C.K. will prove most acceptable. In an easy and non-technical fashion (1) Prof. Praeger sets forth the conditions under which various types of flowering plants exist, the problems by which they are confronted, and the devices by which they triumph. He brings forcibly to mind the deep philosophical nature of the questions that may be raised by the occurrence on hill or in valley of even the humblest plant.

(2) Prof. Arthur Thomson's book is a delightful companion for any one who wishes to enjoy intelligently a holiday among our moors and mountains. It touches in a stimulating and suggestive way on almost every branch of natural history in these favourite districts, and opens out numerous fields of research for the reader.

Practical School Gardening. By P. Elford and S. Heaton. Second Edition. Pp. 224. (Oxford: At the Clarendon Press, 1921.) 3*s*. 6*d*. net.

Messrs. Elford and Heaton have had very considerable experience in organising school gardens and making them fit into the educational scheme, and they have produced a volume which has already proved its usefulness, so that it now passes into a second edition. The authors insist that the combination of School Gardening and Nature Study when properly co-ordinated with the rest of the work in the school can be, and often are, a valuable means of education. Most teachers would agree, but difficulties do undoubtedly arise when an attempt is made to put this excellent general principle into practice. Given a plot of ground, a class, and a limited but definite time each week, how is the teacher to proceed in order that the children may derive the maximum educational benefit? The practical details that need attention, the pests, weeds, and other troubles that are likely to cause trouble, and the many difficulties that crop up as soon as one begins to cultivate the soil, are effectively dealt with. The authors urge that a school reference library might with advantage be formed, but they give no suggestions to this end. In a future edition a list of suitable books might well be added.

Laboratory Manual of the Technic of Basal Metabolic Rate Determinations. By Dr. W. M. Boothby and Dr. Irene Sandiford. Pp. 117. (Philadelphia and London: W. B. Saunders Company, 1920.) Price 24*s*. net.

The authors consider that the results of indirect calorimetry should not be thrown into general discredit as a means of clinical diagnosis, by neglect of details requisite for a true basal metabolic rate. In their well-illustrated book they have certainly set a good example in the matter of detail. They describe the method in use at the Mayo Clinic, Rochester, Minnesota. The patient inspires the atmospheric air through a mask, and the expired air is collected and measured in a gasometer (Tissot) from which samples of air are taken for analysis of carbon dioxide and oxygen by the Haldane gas analysis apparatus, the calculations being carried out as usual. The advantages of this method, and perhaps the disadvantages of other methods, are somewhat emphasised. The authors deserve credit for the very careful directions for all stages of the technique. The book contains a special note for calculation of metabolic rate of a diabetic, a bibliography, an appendix with all the tables required for calculations, and an index. Indirect calorimetry has certainly proved its value in cases of thyroid disease.

Some Account of the Oxford University Press, 1468–1921. Pp. 112. (Oxford: Clarendon Press, 1922.) 5*s*.

This is a charming monograph describing the work of a great institution. The book is a masterpiece of typography, and is embellished by a number of reproductions of old woodcuts and recent photographs. Special chapters are devoted to its most important publications—the Oxford English Dictionary and the Dictionary of National Biography. The vast operations of the Press may be judged by the fact that its warehouses at Oxford are estimated to contain 3½ million copies of about 4500 distinct works. From these vaults was drawn into the upper air, in 1907, the last copy of Wilkins's "Coptic New Testament," published in 1716, the paper scarcely discoloured and the impression still black and brilliant. During the War, the Press carried out much confidential work for the Naval Intelligence Department, and supplied during three years 4½ million copies of the New Testament for use in the field. The relations of the Press to its servants have always been amicable, and the case of the late Mr. J. C. Pembrey, one of the proof-readers, is probably unique: in 1847 he read Wilson's "Sanskrit Grammar," and in 1916 the "Vedic Grammar" of Prof. Macdonell.

Animal Life of the British Isles: A Pocket Guide to the Mammals, Reptiles, and Batrachians of Wayside and Woodland. By E. Step. (The Wayside and Woodland Series.) Pp. vii + 184 + 111 plates. (London and New York: Frederick Warne and Co., Ltd., 1921.) 10*s*. 6*d*. net.

This handy little volume will be welcomed by a large number of amateur naturalists, and can be cordially recommended to all who wish for full and accurate knowledge of the habits, life histories, and appearances of those members of the British fauna that are included in the three classes specified in the sub-title. Hitherto it has not been possible to secure such information within the covers of a single small volume, nor in any one work at so low a price. The illustrations are excellent, the plain being from the work of our best naturalist photographers, such as Messrs. Douglas English, Oxley Grabham, and others, while forty-eight photographs in the natural colours are to the credit of Mr. W. J. Stokoe. The co-operation of these talented artists with the author results in a very satisfactory pocket guide.

British Insect Life: A Popular Introduction to Entomology. By E. Step. Pp. 264 + 32 plates. (London: T. Werner Laurie, Ltd., N.D.) 10*s*. 6*d*. net.

Attempts to give "popular" accounts of the several orders, families, and other subdivisions into which insects are classified almost invariably fail from lack of the courage needed to set before the general reader those details of structure that must be mastered in order to discriminate order from order, genus from genus, and, still more, species from species. In the absence of such information books such as this by Mr. Step become, except to those already versed in entomology, meaningless in many of their pages. We should welcome statements which would enable the enthusiastic beginner to determine whether the specimen in his hand was, say, a stone-fly, a may-fly, a lacewing-fly, or a caddis-fly; and others rendering clear the structural differences between, say, the pierid and the nymphalid butterflies; and so on. We decline to believe that shirking the difficulties will ever popularise or in any way benefit the science of entomology. The figures in the plates of this book are unfortunately not numbered; thus the uninstructed reader is left in doubts as to the application of the numbers given in the respective legends.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Mind.

THERE seems to me now to be some prospect of agreement that, since all characters are equally products of nature (potentiality, capacity, predisposition, diathesis) and fitting nurture, all must be equally innate, acquired, germinal, somatic, and inheritable. *If* that be the case, the problem of inheritance is settled. Doubtless some biologists will continue to discuss such things as the transmission of characters and the intensity of inheritance, but the impossibility of defining their terms and explaining what they mean will always vitiate their labours.

Whatever other tasks biology has before it, two are of prime importance: (*a*) to determine what characters are evoked in individuals by such influences as food, moisture, light, temperature, hormones, use, injury, and the like, and (*b*) to trace the evolution of races, which implies tracing the changes in their natures (*i.e.* in germ-plasms as indicated by changes in characters), which, since the nature of every race is the sum of its potentialities, in turn implies tracing changes in potentialities for development. In both these tasks biology must seek its data from the subsidiary sciences of physiology and psychology.

The kinds of nurture with which we are most familiar, and which we can most easily observe in action, are injury and use. Here, therefore, we are best able to note to what extent individuals are capable of developing in response to given influences, and to what extent species have altered with respect to their capacities for development. Both injury and use confer adaptability on the individual. Injury need not detain us long. Many plants and some lower animals are capable of developing greatly in response to it. Thus a begonia or a sponge may be completely regenerated from a fragment. A lobster can regenerate its claw and a lizard its tail. Higher animals merely heal injuries by means of scars. In them this capacity has undergone retrogression and has been replaced (or supplemented) by that which confers much more adaptability—the capacity of developing in response to use.

It would seem that the power of developing in response to use is a late and a high product of evolution. At any rate, since it is inappreciable in low, and progressively more evolved in higher, animals, presumably it must have had a beginning somewhere in the scale. Presumably also, since a structure cannot be used before it exists, the individual recapitulates in this particular, as in others, the evolution of his race.

The evidence is much clearer as regards mind. I take it that mind is associated with movement; its function is to cause the individual to take action. A reflex action may be associated with consciousness. Some reflex actions (*e.g.* sneezing) are even initiated by consciousness. Some (*e.g.* breathing) can be controlled to some extent by the will; but no reflex action is *initiated* by the will. Thus, when we cough at will the action is not reflex. Reflex actions, therefore, may be defined as those which are initiated by stimuli other than will. On the other hand, an instinct is always and altogether a mental thing—a mental impulse, an emotion, an inclination, a desire to do a certain action, the instinctive action. Like reflexes, it develops in the individual apart from mental experience which merely awakens it to activity, but does not create it. In other words, an instinct is not learned; it is not a product of the functional activity of the mind, but develops in response to quite different influences (*e.g.* hormones). It is not a complex reflex; some reflex actions (*e.g.* sneezing) are quite as complex as some instinctive actions (*e.g.* infantile crying). An instinctive action differs from a reflex action in that it is always *voluntary*. The individual performs the action because he *wants* to do so. If there were no desire, there would be no action. I am aware that all this is unorthodox. Nevertheless, it is true, as any one may discover by examining his own instincts. Does he not, for example, eat, and drink, and sport, and make love through desire? Did he *learn* to feel these desires? I am aware also that at this stage it is customary to discuss the metaphysics of mind and will. I have tried to do so elsewhere, but it is unnecessary here. It is enough that mind, including will, exists and appears to influence the body as gravitation appears (as incomprehensibly) to influence the planets. Instinct may be defined as desire which develops in response to influences other than functional activity.

Habit, intelligence, and reason are in a different category. They are all products of learning, of mental growth due to the functional activity of the mind. An animal is intelligent in proportion as it profits mentally from experience—that is, in proportion as its past sheds a light on, and serves as a guide for, its present and its future. The animal then stores experiences and *re*collects them. Thus its mind grows. We have given a special name to the power of growing mentally in response to use, though the word is used somewhat vaguely. We call it memory. We speak of a man with a good or bad memory, with good or poor powers of learning.

There are two sorts of memory, conscious and subconscious. Again I am unorthodox, but my words have real meanings. We learn two sorts of things: (*a*) facts and the like, which we can recall to mind and which belong to the conscious memory, and (*b*) skill and facility in thinking and doing (mental habits) which cannot in the same sense be recalled, and which, therefore, belong to the subconscious memory. For example, I can recollect a good deal about golf clubs, balls, courses, and adventures; but all this is quite distinct from other sorts of learning, which I cannot in the same sense recall, and, therefore, cannot describe, which enable me to play skilfully (to a humiliatingly small degree). The greatest golfers do not know the very names of the muscles which they have learned to co-ordinate with such exactness and facility.

Consider the caterpillar. He comes out of the egg and, equipped with instincts, at once sets about the business of life. He seeks his food and devours it; he hides from enemies; at the proper time and place he builds a cocoon, and as a butterfly does all sorts of new actions of which also he can have had no previous experience. Apparently he learns nothing; he has little or no memory. Learning would be useless to him; for, unprotected and untaught as he is, he must always act correctly and at once, or perish. He can "bear in mind" for a little while, as a sound lingers on a harp-string. But he cannot recall, as a sound is reproduced by a gramophone. He can feel (*e.g.* pleasure and pain, desire and aversion), but he cannot think (compare, associate, imagine, and the like); for without learning he has nothing to think about. Because his past is a blank he cannot forecast his future, which, therefore, is a blank also. He lives only in the immediate present—a knife-edge of time. Since he has little or no power of profiting by

experience, he is not adaptable; he moves in much the same groove as did his ancestors of a million years ago.

Higher than the caterpillar in the animal scale, the power of growing mentally in response to functional activity is clearly in being. Animals are able to recognise mates and offspring, and the latter are able to recognise their guardians. Family life begins. The offspring, more or less helpless at birth, but protected by their guardians, have ability and opportunity to develop physically and mentally in response to functional activity until they are able to fend for themselves. They begin to think, they become adaptable. This evolution culminates in man, who is born so helpless that he cannot even seek the breast, but who learns so enormously that he becomes rational. Reason is merely intelligence *in excelsis*. A vast and complex store of experience then lights a complex, and perhaps distant, future. Compare three human individuals—an idiot, a newly born baby, and a normal man. The idiot cannot learn, and has not learned; the baby can learn, but has not learned; the normal man can learn, and has learned. There in a nutshell is all the mental difference between them, except that the baby has not yet developed a few instincts. The idiot has these instincts, but, probably because he has lacked some hormone, has reverted by mutation (himself or by some progenitor) to an enormously remote ancestry in which the power of learning was defective. One day I think we shall cure idiocy by the injection of the proper glandular extract. Compare a man with a dog: how enormously greater is the human power of learning, and, therefore, of thinking. Compare him with a housefly: the fly settles on the hand; we strike at it; impelled by instinct, it shoots away; a moment after, having ceased to "bear in mind," it is back again, unmindful of a danger the recollection of which would set a man shuddering for years. We are able to domesticate animals only when they have the capacity to learn to tolerate, to obey, and, when the intelligence is very great (*e.g.* dog), even to love us. Savage man is so intelligent that he has invented language by means of which he is able to hand on the accumulated traditions of generations. Civilised man differs from him in that he has invented aids to his powers of remembering (*e.g.* books of reference), of thinking (*e.g.* mathematics), and of doing (*e.g.* tools). The retrogression of instinct and its replacement by intelligence is well illustrated by maternal care among brutes and men. Among the former it is instinctive, but women have to learn how to tend their young. Again, while insects walk instinctively, men learn. Among the higher animals the number of offspring is controlled by the number which can be protected and taught.

This or that naturalist may disagree as to this or that detail of what I have written about mind, but with the main argument I think all must agree. Already, in practice if not in theory, actions which are not initiated by the will are called reflex; those which are initiated by the will, but in which learning plays no part, are called instinctive; while those which are both initiated by the will and result from learning are called intelligent. As to the evolution of the potentiality of developing in response to use, the truth is glaringly obvious. Even a schoolboy knows that he can teach a beetle nothing, a cat a little, a dog more, and a child much. But all this is incompatible with Lamarck's first law, which has met with such general acceptance. As regards body, the evolution may be more difficult to trace. At any rate, it has not been studied. But as regards mind it is as clear as sunlight. Plainly, an animal is intelligent in proportion as it is able to profit from experience; man's reason and intellect depend wholly on his power of learning; and, as well as I can judge, whenever an animal is capable of learning it is also capable of developing physically in a corresponding degree in response to the stimulus of use.

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Pencil Markings in the Bodleian Library.

IN a former communication (NATURE, 1920, vol. 105, p. 12) I described a method of distinguishing microscopically between the markings made upon paper with different kinds of pencils, and gave some account of the characteristics of early pencil writings in the British Museum.

I am now indebted to the Librarian of the Bodleian Library and to Dr. Craster for their kindness in giving me facilities for studying similar early specimens of pencil writing in that library.

In Schönemann's work on the examination of early MSS. ("Versuch eines Systems der Diplomatik," 1818, vol. ii. p. 108) it is stated that the ruled lines in various documents of the eleventh and twelfth centuries are in a graphite pigment. Referring to this statement I pointed out (*loc. cit.*) that, since graphite was only discovered in 1560, it was obvious that Schönemann must have mistaken ordinary metallic lead for graphite.

The historical basis for my criticism is to be found in Gesner's "De Rerum Fossilium Lapidum et Gemmarum Genere," 1565, vol. ii. p. 105, and in Beckmann's "Beiträge zur Geschichte der Erfindungen" (1780). It appears, however, that graphite must have been known long before that time, for, after reading my communication, Prof. Flinders Petrie informed me that he had discovered a lump of graphite at Ghorub, which must have dated back to a period between 1500 and 1200 B.C., although there was no evidence that graphite was ever used as a pigment in ancient Egypt.

This unique specimen of graphite, a portion of which Prof. Flinders Petrie has kindly given me for examination, is a decidedly coarse, impure mineral, containing only 39·4 per cent. of carbon, and the amount of silicious impurities present is plainly indicated by the pronounced irregular striations in the markings on paper.

This proof that graphite was known ages before its reputed discovery in 1560 in the Borrowdale mine, gives an added interest to the examination of the earliest pencil markings available in this country.

The earliest known instance of pencil marking in the Bodleian is a vellum MS. Commentary on the Book of Job of the thirteenth century (Auct. D. iii. 14). This has vertical lines, ruled with a stylus down the sides of the writing, and the microscope shows that the pigment of these is lead or other metal.

In the "Opuscula Varia SS. Augustini et Bernardi" of the thirteenth and fourteenth centuries (Hatton MS. 102), the ruled lines surrounding the text are in a red ink in some of the MSS., whilst in others they are in a metallic pigment. In another Hatton MS. (No. 107) of the fourteenth century, no pencil markings are present, the ruled lines at the side and the annotations being in a pale brown ink.

The "Opera Johannis Dastyn" of 1590 (Bodl. MS. 485) is written in ink, and shows pencil strokes at the side written in graphite, but there is no evidence that these markings were contemporaneous with the body of the MS.

An Italian MS. on paper, "Geomantia" (Digby MS. 133), written in ink prior to 1634, shows fine ruled lines at the side in a brilliant metallic pigment;

and the annotations in a Hebrew MS. "Jad Chazaka" (Poc. 235) of about 1650 are also in lead or a lead alloy.

The notebook of the Swiss scholar Casaubon, (Casaubon MS. 61), written about 1613, is particularly interesting. The leaves of the book are of thick horn and are covered on each side with minute writing, which is in a metallic pigment, showing much finer spicules than is usual in the writing done with a metal style. It resembles the pigment used in the drawings of the Stowe MS. "Arms of Ancient Nobilitie" of the early seventeenth century (British Museum).

A series of almanacs interleaved and containing Anthony Wood's Diary from 1676 to 1685 (Wood's Diaries 20–29, 742), shows ruled lines in a metallic pigment, while the entries in the diaries are either in ink or, less frequently, in pencil. Referring to the latter entries, the Rev. Andrew Clark remarked ("Life and Times of Anthony Wood," I. 3 Oxf. Hist. Soc., 1891): "Wood's pencil, I assume, was not graphite, but actual lead. It has left a faint mark, almost illegible, except for the indentation of the paper." Microscopical examination of these entries down to 1685 showed that this assumption was correct, none of the writing having the characteristics of graphite.

At a later date, however, Wood appears to have had a graphite pencil. "A Collection of Poems on Affairs of State," London, 1689 (Wood, 382) has a note on its flyleaf in the writing of Wood: "Bought at Oxon. 26 Feb. 1688." (The discrepancy between the dates is explained by the use of the old style for one of them.) This writing has the appearance of ordinary graphite, the masses of black pigment being uniformly distributed, and none of the particles showing the lustre or striation of lead or its alloys.

With the very doubtful exception of the markings in the MS. of Johannis Dastyn (*supra*), this is the earliest writing in graphite pencil noted in the Bodleian Library.

It will be recalled that the earliest graphite writing found in the British Museum was in two Notebooks of Sir Thomas Cotton, one of about 1630–1640 and the other 1640–1644.

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Haloes and Earth-History: A New Radioactive Element.

IN the Archæan black mica of Yitterby, very small, colourless, spherical, halo-like forms occur. The mica is, as it were, bleached within these halo-spheres. Many show a central opaque particle or nucleus. In the case of others it is difficult to be sure of the presence of a nucleus, or it may take the form of a limpid refracting particle. The optical appearances suggest that in these spheres the refractive index of the mica has been raised.

They are very small. A cluster of these minute haloes, amounting to many hundreds, presents with a low power the appearance of a starry sky. The average diameter appears to be 0·01 mm., no allowance being made for the nucleus. The greater number are remarkably uniform in diameter. Thus, readings of 23 of these haloes, taken at random, range from 50 to 59 scale divisions of the micrometer. A few larger ones are present, but, as in most cases their greater size is directly referable to an aggregation of nuclear particles occupying a large central volume, it seems safe to conclude that these limpid spheres are in reality of one size only.

The mica flake in which this cluster occurs is 0·018 mm. thick, or perhaps a little less. The minute spheres are located at various depths in the mica—some below the surface, some more or less truncated. Many are sharp and easily measured; others, as would be expected, are diffuse upon the edge.

I have been for some years aware of the existence of these haloes—since a period before the war—but, during the occupation of my laboratory by troops in 1916, among other things lost was the specimen of Yitterby mica from which my slides were obtained. A few other samples of this mica did not appear to contain them. Nor could I form any probable theory to account for them. Their uniform size convinced me that they were radioactive. The hypothesis that they might be due to slow β-radiation had really nothing to support it: no similar effect having been found in any other mica. Later I concluded that they must be reversed haloes such as I found in the Devonian mica of Co. Carlow. There were other appearances to support this view. Thus in the very similar Archæan mica from Arendal, bleached uranium haloes in various stages were found. Again, in both the Yitterby and Arendal mica, semi-bleached bands occur having a centrally placed line of what are probably radioactive particles disposed like a central moraine on a glacier. But with these appearances of reversal were vigorous haloes in all stages of development.

Recently, Dr. Prior was so good as to send me some flakes of Yitterby mica. In them I found all the appearances described above, including a few of the minute bleached halo-spheres.

The idea that this bleaching of the Archæan micas might be due to former high temperature conditions led to a test of the behaviour of the Carlow mica at different temperatures. It was found that a halo-rich specimen of this mica after an hour's exposure to a temperature of about 730° C. had acquired many of the characters of the Archæan micas. Most of the haloes had disappeared, and some had left a bleached area giving quite characteristic readings. Bleached bands, also, had taken the place of linear radioactive staining; and the originating radioactive particles were exposed to view forming a central line.

There is, I think, no doubt that these (and other) appearances show that the Yitterby and Arendal Archæan micas were at some remote period subjected to a temperature probably not much exceeding 700° C. during which a prior-existing crop of haloes were obliterated or reversed, and that, therefore, the existing haloes are a second crop which originated from the same nuclei when the thermal conditions permitted their development. This history has a good deal that is fortuitous connected with it. Some three hundred additional degrees of temperature would have reduced the mica to a slag.

But what is to be inferred as to the nature of the minute halo-spheres? A chance find seems to bear upon their origin.

In the mica of Arendal uranium haloes are fairly abundant; they occur in every stage of development. Within some of the earliest rings having radial dimensions reading from 0·0150 to 0·0160 (corresponding to rings which in Devonian mica read 0·0145) a very minute ring is sometimes seen. It is a difficult object and needs good lighting and good sight to detect. This ring surrounds the point-like nucleus with perfect centricity, an intervening band of unstained mica being apparent. The radius of this ring has been read from 0·0049 to 0·0057. The effect of the nuclear dimensions on a ring so small

is considerable. I make no correction for it here. Presumably we are dealing with an α-ray of the same range as that which must have been concerned in the genesis of the Yitterby haloes.

This range, if taken as 0·005 mm., would correspond to about 1 cm. in air at 15° C. The radioactive element concerned, although associated with the uranium family of elements in the Arendal mica, cannot be a member of that family. This appears from the value which in such a case we must ascribe to λ. It would decay at a rate some billions of times slower than uranium according to an extrapolation on the Geiger-Nutall curve. Now the ring in the Arendal mica must have been formed since early Archæan time and from a nucleus of point-like dimensions.

From all this there seems good evidence that a radioactive element exists (or formerly existed) emitting an α-ray having a range of about one centimetre in air. So far no evidence of its further disintegration has been found.

It seems probable that the development of the small Yitterby halo-spheres represents a very considerable period of time. It will be of interest to see if similar evidence for what appears to be a very long period of Earth-history, seemingly preceding early Archæan time, will be forthcoming from material found elsewhere. It is possible that this period preceded the thermal conditions which generally prevailed during Archæan time and that the survival of the evidence contained in the Yitterby mica was due to local fortuitous conditions. These haloes would, in that case, be a record carried from one geological age to the next.

I wonder am I justified in naming an element from such evidence as I have found—the range of an α-ray? I think it has been done before. If ever it is isolated I would ask the finder to call it Hibernium after this beautiful but most unhappy country.

J. JOLY.

Trinity College, Dublin, April 8.

The Helmholtz Theory of Hearing.

ON a visit to the Cambridge Physiological Laboratory not long ago Dr. Hartridge demonstrated an apparatus of his design that showed the effect of a repeated sinusoid vibration on a series of pendulums of different periods. Each of a series of weights was suspended from a horizontal bar. The strings were all of different lengths; each pendulum had thus a different period. The horizontal bar was connected with a wheel so that it could be moved back and forth harmonically.

When the wheel was started, all the pendulums began to vibrate. As the wheel continued its rotations, the pendulums gradually came to rest—except one, namely, that one the natural period of which corresponded with that of the rotating wheel. This proved that with a continuous series of vibrations only a pendulum with a harmonic period would be maintained in vibration. It also proved that a single vibration set *all* pendulums in vibration no matter what natural periods they might have. Dr. Hartridge has thus demonstrated that if the ear possesses a series of resonating organs *every one* will respond to the first vibration and will come to rest only when this vibration has been several times repeated.

When a person sings a glide from one note to another, his voice produces vibrations that are all different. Every one of these vibrations is the first of its kind, and at no moment is there a succession of waves of the same period. Consequently at every single vibration *all* the resonators in the ear are set in vibration, and this vibration of all of them continues throughout the glide. In speech the voice is never still for an instant. Every vibration from the larynx differs from the one before. Therefore in perceiving speech *every* resonance organ of the ear must act at every instant for every vibration of the voice.

Dr. Hartridge has given a complete and final proof that, if the ear possesses a set of resonating organs, they must all respond together for each new vibration; as the changing tone of speech has a new vibration at every instant, they must all respond alike at every instant and for every tone.

According to the Helmholtz theory each vibration acts on a different resonator in the ear. In the sliding tone always used in speech each single vibration must, according to Helmholtz, pick out a corresponding resonator. It is easy mathematically to show that this cannot be true and that each single vibration of the voice in speech must set all resonators in action. Nobody seems to have thought of this, and it has remained for Dr. Hartridge's highly ingenious apparatus to kill finally the Helmholtz theory of hearing.

In the April number of the *British Journal of Psychology*, Dr. Hartridge gives as the fundamental reason for supporting the Helmholtz hypothesis that the experiments described by him show that there are resonators somewhere. As pointed out above, they show exactly the opposite, namely, that there cannot be any resonators anywhere. If there cannot be any resonators, then the hypothesis that the ear acts as a resonating apparatus becomes an impossible one.

E. W. SCRIPTURE.

Boyle's Experiments on Capillarity.

IN Mr. Hardy's interesting "Historical Notes upon Surface Energy and Forces of Short Range," NATURE, March 23, p. 375, he says that "Boyle tried, but failed, to observe whether the (capillary) rise took place in a vacuum." Boyle writes in Experiment XXXV. of the "New Experiments Physico-Mechanical" that after showing the capillary rise in open air, "We tried indeed, by conveying a very slender pipe and a small vessel of water into our engine (air pump receiver), whether or no the exsuction of the ambient air would assist us to find the cause of the ascension we have been speaking of; but though we employed red wine instead of water, yet we could scarcely perceive through so much glass, as was interposed betwixt our eyes and the liquor, what happened in a pipe so slender, that the redness of the wine was scarcely sensible in it. But, as far as we could discern, there happened no great alteration to the liquor; which seemed the less strange, because the spring of that air, that might depress the water in the pipe, was equally debilitated with that, which remained to press upon the surface of the water in the glass." Boyle was a very careful and accurate experimenter, and he was trying to find whether there was an alteration in the capillary height *in vacuo*. His experiment was quite accurate and is worthy of his great reputation.

SIDNEY SKINNER.

South-Western Polytechnic Institute, Chelsea, London, S.W., April 6.

Problems in the Variability of Spectra.[1]

By Prof. THOMAS R. MERTON, F.R.S.

IT has been known for many years that the radiations which an element emits in the state of a luminous gas are not invariable but depend on the presence of other elements, the manner in which the substance is excited to luminosity, and other circumstances. It was recognised in some of the earliest investigations that many band spectra were to be associated with compounds and that a spectrum might be due partly to such compounds and partly to uncombined atoms. Thus, for example, if strontium chloride is introduced into the flame of the bunsen burner we find lines associated with the element, bands due to strontium oxide, and also bands due to the chloride, and when strontium bromide is substituted for the chloride the spectrum is the same as regards the lines due to the element and the oxide bands, but bands peculiar to the bromide are found to have replaced those due to the chloride.

Minute quantities of substances can sometimes be detected by means of these characteristic bands due to compounds, a familiar example being the blue flame which is seen when common salt is thrown onto a coal fire and is due to the copper chloride formed from the chlorine in the common salt, and the minute trace of copper which is present in the coal. A number of different elements are present in most flames, and the reactions which occur are probably very complex. In gases contained in vacuum tubes which are excited to luminosity by electrical discharges it is possible to work with pure substances, and a discussion of the spectra observed is simpler.

In the case of gases in vacuum tubes the spectrum sometimes consists of bands, and the band spectrum from the negative pole may be different from that seen in the positive column. Thus nitrogen, when excited by uncondensed discharges, shows in the visible regions two band spectra, one known as the positive band spectrum, which appears in the capillary of a vacuum tube of the conventional type, and the negative band spectrum, found in the neighbourhood of the cathode, which constitutes an important part of the spectrum of the aurora.

Both these band spectra, and indeed all band spectra, are generally attributed to molecules rather than atoms, but if a condensed discharge is passed through nitrogen the spark spectrum associated with the nitrogen atom is obtained, and this is capable of further modification when discharges of great intensity are employed. The action of the condensed discharge is almost certainly due to the greatly increased current density which obtains during the very brief periods while the discharge is passing. Its first effect is to break up the molecules into atoms, and the further stages brought about by an increase in the intensity of the discharge are generally supposed to be due to the removal of successive electrons from the atoms. There are other methods by which the current density can be increased with similar changes in the spectrum; the effect of an increase in the current density is to increase the number of charged particles in a given volume of the gas, with the result that a large number of the radiating atoms are subjected to intense electric fields due to neighbouring charged particles.

Similar results are observed in the spectra associated with carbon. There are at least six spectra due to compounds of carbon with hydrogen, oxygen and nitrogen, and special experimental conditions are necessary for the production of some of these spectra. In addition to these band spectra carbon shows line spectra, and with the most intense discharges which can be employed in the laboratory a number of new lines appear which are also found in the spectra of the hottest type of stars, known as the Class O, or Wolf-Rayet stars.

All these changes can be reasonably accounted for, but there are a number of other changes which are more difficult to explain. For many reasons the spectrum of hydrogen is of particular interest, because the atom of hydrogen is the simplest known atom and is supposed to consist of a positive nucleus and a single electron. There are two spectra associated with hydrogen, one of which, the Balmer series, is found in almost all celestial spectra and also in vacuum tubes in the laboratory unless the most rigorous precautions are taken to exclude all traces of hydrogen. The explanation of the origin of this spectrum has been one of the most striking successes of the quantum theory of spectra developed by Bohr and by Sommerfeld. The other spectrum of hydrogen, known as the secondary spectrum, consists of an enormous number of lines and differs in its mode of production from the Balmer series in that the secondary spectrum is characteristic of pure hydrogen. In the purest hydrogen obtainable the secondary spectrum may be as bright as the Balmer series, but if the smallest trace of impurity is present the Balmer series gains in intensity and the secondary spectrum becomes very much weaker. In a vacuum tube containing water vapour the lines of the Balmer series are extremely intense whilst those of the secondary spectrum are relatively very faint. The investigations of Michelson and Lord Rayleigh, and of Buisson and Fabry have shown that under certain conditions the masses of the atoms or molecules from which the spectrum originates may be deduced from a knowledge of the widths of the spectrum lines, and recent investigations, in which the widths of the lines of the secondary spectrum of hydrogen have been measured to a high degree of precision, have shown that the secondary spectrum is to be referred to the hydrogen molecule.

The presence of impurities in vacuum tubes containing hydrogen not only enhances the lines of the Balmer series but also brings about changes in the relative intensities of the Balmer lines themselves. Some of these changes are very striking, but there are other variations of a more subtle kind which are only discovered when accurate quantitative measurements are made of the relative intensities of the lines. A most striking effect is observed when a relatively large quantity of helium is admitted to a vacuum tube containing hydrogen. Under these conditions the

[1] From a discourse delivered at the Royal Institution on Friday, March 10.

relative intensities of some of the lines of the secondary spectrum alter in a surprising manner, some of the lines being greatly enhanced whilst others become very weak.

From a theoretical point of view the spectrum of helium is second in importance only to that of hydrogen. The lines of helium are prominent in the spectrum of the chromosphere of the sun and of many stars, and their relative intensity varies under different conditions of excitation in the laboratory and in different celestial spectra. There are six chief series of lines in the spectrum of helium, three of which are usually referred to as the "helium" and three as the "parhelium" series. The helium series are the stronger in vacuum tubes containing the gas at pressures exceeding a few millimetres, whilst at very low pressures the parhelium series are predominant. Since the chief visible line of the helium series is yellow and that of the parhelium series green, the colour of the discharge is changed from yellow to green when the pressure is reduced.

There is another spectrum associated with helium which is analogous to the secondary spectrum of hydrogen in that it appears with any considerable intensity only when the gas is exceedingly pure. This spectrum is known as the band spectrum of helium, and its occurrence in a gas which is known to be incapable of forming molecules in the chemical sense of the word is very remarkable, in view of the fact that band spectra are generally attributed to molecules. It may perhaps be suspected that there is some temporary association of atoms during the passage of the electric discharge which cannot be referred to as a molecule in the chemical sense of the word. Prof. A. Fowler has shown that the arrangement of the heads of the bands in this spectrum resembles that found in series of lines which are due to atoms, though the arrangement of the lines which constitute each band is of the type usually found in band spectra.

When powerful condensed discharges are passed through helium a spark spectrum is developed. Two series in this spectrum are known as the 4686 and the T Puppis series, and their discovery by Prof. Fowler has led to some of the most important developments of theoretical spectroscopy. These spark lines of helium are found in the nebulæ and early type stars, and are attributed to helium atoms which have lost an electron.

The energy required to produce spark spectra varies widely with the nature of the gas under investigation, and for elements of the same chemical group is, as a rule, smaller the greater the atomic weight of the element. Thus in the case of helium powerful discharges are required for the production of the spark spectrum and the lines of the arc series are always bright. In the case of argon a much less intense discharge is required to produce the spark lines, and with very powerful discharges the arc lines disappear almost entirely from the spectrum. In addition to the production of these spark spectra one of the effects of powerful condensed discharges is to alter the relative intensities of the arc lines. Generally speaking, the effect of an increase of energy on a particular series of lines is to enhance relatively the more refrangible members of the series, but the effect varies in degree for different series. Experiments of this kind enable us to imitate to some extent in the laboratory the distribution of intensity amongst the lines which is found in the nebular and stellar spectra.

It will be seen that whilst many variations in spectra can be referred to different compounds, to molecules, and to uncombined atoms in successive stages of ionisation, there are a number of other changes for which there is at present no obvious theoretical explanation. The possibility of some specific influence of one gas on the spectrum of another must now be recognised apart from the formation of chemical compounds, which, in the action of helium on the spectrum of hydrogen, for example, appears to be excluded. There is also other evidence, based on a study of the broadening of spectrum lines, of a specific action on neighbouring atoms. We are still awaiting a satisfactory theoretical explanation of phenomena of this kind, though it is now forty years since what is perhaps the first known example, the action of sodium on the absorption spectrum of magnesium vapour, was observed by Prof. Liveing and Sir James Dewar at the Royal Institution.

Mathematics and Public Opinion.

PERHAPS few well-known mathematicians have escaped an experience which would be amusing if it were not so exasperating. Mr. Brown (let us say) is introduced to Prof. Smith, who teaches mathematics at a provincial college. After the usual expression of pleasure at the introduction, Brown generally adds "Of course, although I haven't had the pleasure of *meeting* you before, I know you well by reputation." Then, without so much as pausing to take breath, he proceeds to explain that he was always a duffer in "maths" at school, and that he has now forgotten everything about the subject they tried to teach him as a boy. Now Brown doesn't act in this way to every celebrity. If introduced to Dr. Lasker, and unaware that he is a distinguished mathematician, he does not seize the first opportunity of telling him that, although he occasionally plays draughts with his wife in the evening, chess was always beyond him, and he could not remember the simplest openings. Still less does he act in this way if his new acquaintance is a sportsman or an epicure. Moreover, in making his lamentable confession, Brown shows no sign of regret or humiliation; on the contrary, a sort of satisfied look steals over his face, suggesting that he is glad to be free once for all from the study of such a repulsive and useless subject. England is perhaps the only country where such an occurrence is fairly frequent; and this fact suggests some very unpleasant reflections.

One thing clear from Brown's attitude is that he evidently fears lest Smith should introduce some mathematical topic during the conversation. Of course this is the thing Smith is most unlikely to do. If this were all, it would be as harmless as the caricatures of professors and policemen which we see on the stage. But there is a very serious additional

reason for Brown's behaviour. An admirable Report has just been published in which it has been thought necessary to emphasise the obvious fact, that an English student who intends to pursue a course in the humanities must, first of all, have a sound and fairly extensive knowledge of his own language and literature. Unless this foundation is well and truly laid, the student's equipment is imperfect, and he is severely handicapped at every turn.

Now, mathematics occupies a precisely similar position with regard to a course in science. To give a full justification of this statement is, of course, impossible here; but an attempt to do so partially will be made by putting an imaginary case. Let us suppose that progress in mathematics had stopped abruptly at the end of the 15th century, a comparatively recent date in the history of the science. The result would be that physics would be almost entirely empirical; there would be no theories at all to account for the motions of the heavenly bodies, for the transformations and indestructibility of energy; no general theories, capable of verification, in physical optics, heat, or electricity. It is extremely unlikely, not to say impossible, that instruments like modern telescopes, microscopes, spectroscopes, or electric and electromagnetic meters of various kinds, could have been invented. Some, at least, of the consequences involved in this can be seen by everyone who considers the matter.

To turn to more banausic or, if the reader prefer it, practical considerations: a single example must suffice. Let us suppose that "practical" engineers had succeeded in constructing a steel steamship, approximating to the modern type. (This in itself is taking a good deal for granted.) The induced variations of its compass would have to be corrected by a blind and tedious process of trial; the skipper would have no Nautical Almanack, no means of determining the exact local time (and consequently his true longitude), no rules to guide him in keeping a great circle course from one given port to another. Similarly biologists and chemists are indebted to physicists and mathematicians for the perfection of their instruments; and such topics as heredity and Mendelism require for their full discussion a good deal of mathematics. Physiology, too, is becoming daily more dependent on physical theory and mathematical formulæ; for instance, a full explanation of the rise of sap in trees must involve a mathematical theory.

Such examples might be multiplied indefinitely. Let us now turn to another aspect of the question. Benjamin Disraeli, who was by no means the charlatan which some people suppose him to have been, is reported to have said that the best way of gauging the commercial prosperity of a country was to find out the condition of the chemical market. We may venture to assert that the intellectual state of a country may be estimated fairly well by its attitude towards mathematics and its progress therein. In this respect England is much inferior to other and smaller nations. For instance, in England many private libraries have been either given to the nation or placed at the disposal of genuine students: very few of these are wholly or mainly mathematical. Contrast with this the Mittag-Leffler endowment, of which an account will be found in Nature of July 6, 1916, p. 384. The founders expressly emphasised the supreme importance of pure mathematics from a national point of view. Again, no one can dispute the practical efficiency of the American nation; compare their treatment of mathematical professors with ours. An American university teacher may be a specialist devoted to the most abstract and "unpractical" parts of his science; he is left perfectly free to pursue his researches; he is provided with a sufficient staff of assistants; the university library contains an ample store of mathematical books, and all other necessary equipment is supplied. Every seventh year the professor is relieved of his official duties; and the use which he generally makes of his respite may be illustrated by the "History of the Theory of Numbers" (now in course of publication), by Prof. L. E. Dickson. His special subject is the highly abstract one of group-theory: but he spent his sabbatical year in ransacking the libraries of Europe, as well as of the United States, for works on the higher arithmetic. The result is an extraordinary display of laborious and accurate research: the first volume alone contains summaries, almost all of them based upon the author's personal examination, of thousands of papers. The value of the work, when complete, can scarcely be overestimated.

Finally, it is dangerous to neglect mathematics in schemes for a course of general education. From a school teacher's point of view the subject naturally falls into two divisions: (*a*) computation, drawing (including graphs), mensuration, and surveying; and (*b*) the theoretical treatment of the elementary parts of the subject. No attempt should be made at premature specialisation; the needs of the exceptionally gifted pupils may be met by giving them free access (with occasional advice as to choice) to the school library, which should contain books beyond the scope of the school course, and also biographies of mathematicians and works on the history of the subject. The main results to be desired, in the case of an average student, are these, among others: at the end of his course he should have a correct idea of the importance of mathematics and some acquaintance with its aims and methods, whatever his actual acquirements may be. Above all, he should have acquired the habit of intellectual honesty. A mistake in a mathematical exercise cannot be concealed by fudge, or argued about, as in the case of a historical essay or the like.

It is most disheartening to find that an organised attempt is being made to restore the study of Greek and Latin to its old position of prestige; fortunately, a number of eminent classical scholars have taken up a reasonable attitude, so that the danger may not be so great as it seems. Moreover, the report already alluded to should convince everyone that even with regard to the humanities it is not Latin-Greek but English that should be made the principal subject in English schools. The great Greek writers had not been condemned, in their school days, to wearisome lessons in Arabic or Hieroglyphics, although everything now argued in favour of Latin-Greek might have been urged equally well in favour of such preposterous procedure.

G. B. M.

Applications of the Thermionic Valve.[1]

By J. JOSEPH.

THE control of energy at distances of thousands of miles without any other medium than the æther has been made possible by the evolution of the thermionic valve. This remarkable invention can be described briefly as a highly exhausted glass bulb, in which is mounted a tungsten or tantalum filament heated by a battery giving about 6 volts. Electrons are emitted by the heated filament. The filament is surrounded by a grid or gauze cylinder, which is insulated and kept at the negative potential of the filament, while a plate of metal mounted inside the bulb is kept at a high potential of from fifty to several hundred volts by means of a battery or some other source of continuous current. The bulb is highly exhausted, and while the grid is kept at a normal negative potential, steady current passes from the filament to the plate or anode, but as soon as the grid is made slightly positive or negative, the current passing between the filament and anode by virtue of the electronic conductivity is increased or decreased. A valve can be used as a rectifier, as it can be made unilateral in conductivity by suitable adjustments of "grid potential." It can also be regarded as an inertialess relay, it being only necessary for the grid to be affected by the most minute change of potential for the valve to become more or less conductive, when it may be used indirectly to close a circuit and control magnetic or electrical operations.

One of the most important applications of the valve is the amplification of telephone currents in long-distance telephone trunk lines. Here, owing to the length of the cable and to the electrical constants involved, speech becomes greatly attenuated, and thermionic relays or repeaters are introduced about every thirty miles which amplify the speech to its original degree of loudness. In addition, cable of much smaller diameter and weight can be employed, as currents producing almost inaudible sounds can be amplified to any degree of strength. The introduction of these valve relays has effected a saving of thousands of pounds in many of our trunk telephone lines.

Another recent application of the valve is the magnification of the sound of the heart-beat. This is effected by means of a special transmitter, which rests by its own weight over the heart of the patient under examination. The heart creates vibrations in an air-chamber which reproduce exactly the complex action of the blood when passing through the valves of the heart. When connected to a thermionic valve amplifier and a special receiver attached to a large horn, the beat of the heart can be made audible to a number of people in a lecture-room.

The valve has also been used for the simultaneous reproduction of speech with the projection of a film on a screen, both picture and sound vibrations being photographed simultaneously on the same film, thereby ensuring perfect synchronisation. The vibrations of the voice are, by means of microphones, made to agitate a small mirror fitted on the camera adaptor, and a shaft of light passes from the mirror through a narrow slit. As the mirror vibrates, the band of light is reflected at constantly changing angles, and a wave form is produced which corresponds to the vocal sounds of the person speaking, as in the oscillograph. The wave form appears on the side of the film and is reconverted into sounds by means of a selenium cell, which, as is well known, possesses the peculiar property of resisting the passage of electricity in proportion to the intensity of light to which it is subjected. The variations in resistance caused by the passage of the film through the cinematograph are amplified by thermionic valves and made audible through a loud-speaking telephone. There are wide possibilities in this application of the valve.

An important feature of the valve is its great adaptability to the production of sounds of any frequency from one to many millions per second. A valve can be made to generate oscillations if the grid and anode are coupled to coils so as to form a transformer, the circuit of the coils being completed through a battery of 150 volts or more. By connecting a condenser across the anode coil, oscillations are set up, the frequency of which depends on the capacity of the condenser. If a third coil is coupled magnetically to the anode circuit, a note will be emitted corresponding to the frequency of the circuit, and by varying the capacity of the condenser, a wide range of frequencies can be generated for various testing purposes. The note emitted by the receiver is very clear and sharp, and the ease and rapidity with which the frequency can be changed renders the method particularly suitable for aural surgery, where frequencies covering a range of 200 to 3000 are often required. It is well known to aural specialists that certain people have what is known as a silent zone at particular frequencies. For instance, a patient's hearing might be normal for frequencies 200-500 and although he is deaf to frequencies 500-520. The aural appliances at present in use are not suitable for the rapid and accurate production of frequencies of any desired value. With a thermionic generator and a calibration chart, however, the frequency can be varied at will, and if a telephone head-receiver is worn by the patient and connected in series with a variable air condenser and the output or coupling coil, it can be determined readily what frequencies are inaudible to the patient. Further, by varying the capacity of the condenser the sound can be reduced gradually to inaudibility and, by calibration, a scale obtained which will give positions for normal hearing, imperfect hearing, and so on. By this means the effect of treatment can be determined to a very fine degree.

The human ear will not easily respond to frequencies greater than 3000 per second, although frequencies of 18,000 can be detected and instances have been known where 30,000 to 40,000 have also been heard. The frequencies used in wireless telegraphy are governed by the wave-length, and values of 500,000 per second, which correspond to a wave-length of 600 metres, are quite common. In spark telegraphy, the wave trains are

[1] Substance of a contribution to a discussion at the Institution of Electrical Engineers on March 6.

cut up into groups which are rendered audible to the wireless operator by means of a telephone receiver, which gives a click for every wave train, the signal being, of course, first rectified by the valve, so that a succession of musical sounds are heard in the telephone receiver corresponding to the Morse alphabet. The intermediate or high frequencies in each wave train are beyond human audibility, and are therefore not heard. The wave generated by the valve is, however, a continuous one, that is to say, every time the sending key is pressed a group of continuous waves are sent out at a frequency determined by the wave-length. To render them audible in the telephone at the receiving end, a local valve oscillator is used for generating frequencies slightly lower or higher than the received signal and, by heterodyning or superimposing one on the other, a frequency equal to the difference of the two notes is heard in the telephone receiver. This allows of exceedingly fine tuning, for the frequency of the local generator being under the control of the receiving operator, the difference in pitch is adjusted to 1000 cycles, the best value for human reception. It will therefore be seen that frequencies of as low as 1 can readily be detected, although, when the difference becomes very small, there is a tendency for one oscillator to pull the other into step.

Probably, the most interesting application of the thermionic valve is its use in radio-telephony. Here the valve is used to generate continuous waves in a suitable circuit and, by means of a microphone, the voice of the speaker is made to vary the amplitude of this wave at the different audible frequencies which are used in speech formation. These modulations are then conveyed to the aerial, and the telephone diaphragms at the receiving end are correspondingly stimulated and reproduce the speech exactly as transmitted. Numerous other uses have been found for the thermionic valve, among which may be mentioned direction finding, the navigation of aeroplanes in flight, its use as a rectifier for charging batteries, communication between moving trains, and the control of energy at great distances. In the latter direction mention may be made of communication by radiotelephony having been definitely established between England and Australia. Wherever a succession of signals can be received, they can always be amplified and made to operate selective electrical or mechanical relays for controlling power of any magnitude. The future holds a wonderful vision of vast operations at one end of the earth, being controlled by mankind at the other without any other medium than the æther.

Obituary.

Prof. Philippe A. Guye.

By the death of Prof. Philippe Auguste Guye, on March 27, Switzerland loses one of the most eminent of her savants, and the world of science is the poorer by the passing away, in the full maturity of his intellectual powers, of an assiduous and successful cultivator of natural philosophy, distinguished alike for the range and profundity of his knowledge, the force of his genius, his originality, his ingenuity and remarkable experimental skill. Geneva has long been a home of science; some of her citizens are among the most honoured of its votaries, and Guye now assumes his due position on a roll already made illustrious by the names of Saussure, De La Rive, and Marignac.

Philippe A. Guye was born at Saint-Christophe (Vaud) on June 12, 1862. His earliest scientific studies were made at the University of Geneva, where he worked under Graebe, with whom he published papers on diphthalyl and on naphthalene hydrides—a modest enough theme for the 'prentice hand—mainly a repetition of Graebe's observations of ten years previously, which seemed to have been called in question by the subsequent work of Agrestini. After taking his doctorate he repaired to Paris, where he remained some years, working in the laboratory of Friedel. Here he appears to have come under the influence of ideas on spatial chemistry which science owes to Le Bel, and much of his work during the next few years was devoted to their development. In 1892 he was recalled to Geneva to occupy the chair of theoretical and applied chemistry in the university of that city, to which he remained attached for thirty years. During this period Guye, by his energy and personal influence, his organising power, and the catholicity of his scientific aims, made an indelible impression on the academic life and activities of the university. He surrounded himself with a body of earnest and enthusiastic workers, attracted from all parts of the world, to whom he gave freely from a wealth of ideas which ranged over every department of chemical and physical science. It is estimated that upwards of 600 communications emanated from the Geneva laboratory while under his direction, some 200 of which bore his own name alone, many others being joint contributions by himself and his pupils. His own work was characterised by a rigorous sense of accuracy, by caution and a recognition of possible sources of error, amounting almost to intuition, combined with a capacity for generalisation and a *flair* for fruitful hypothesis which seemed, at times, like divination.

Although Guye began his scientific life under the guidance of Graebe, and at a time when the theory of organic chemistry and its technical applications were developing with extraordinary rapidity and success, systematic organic chemistry of the type with which the name of his eminent teacher is associated had few attractions for him, and it is doubtful whether Graebe's teaching and example had any permanent influence on his career. At all events, on his election to the Geneva chair he embarked upon the long series of investigations on problems of physical chemistry on which his fame mainly rests. He was early attracted to the many issues to which the molecular theory of Van der Waals gave rise. He discovered a series of new relations between the physical constants of liquids and their molecular magnitudes, and he greatly

extended the conception of molecular association in liquids. He devised new methods of determining the molecular weights of substances in the liquid state and at the critical point. He attacked the study of molecular dissymmetry, and traced the connection between optical activity and homology in liquids, between isomerism of position and rotatory power, and with the aid of his pupils he accumulated a great mass of experimental material which served to extend and substantiate his generalisations.

In 1903 Guye turned his attention to the study of atomic weights, and, in particular, to a critical examination of the experimental basis upon which these magnitudes rest. He thereby followed and perpetuated a tradition with which the fame of the Geneva school of chemistry, as personified by Marignac, will always be connected. Practically the greater number of the 100 contributions to the literature of chemistry which we owe to Guye's pen during the past twenty years are devoted to this subject, upon which he lavished all the powers of his matured intelligence, his experience, ingenuity, and manipulative skill. Thanks to his organising capacity and the ability and enthusiasm of his collaborators, we have been furnished with a series of fiduciary values which are probably among the best determined of physical constants, in which every known source of error has been rigorously scrutinised, and, so far as possible, eliminated. Naturally the trend of modern developments of ideas concerning the essential nature of the elements, and their fundamental relations and possible interdependence, attracted Guye's alert intelligence, and at the Brussels meeting of the International Conference in June last he pointed out their significance in connection with the proposed reorganisation of the work of the International Committee on Atomic Weights, of which he was an enthusiastic advocate, and on which, had he lived, he would certainly have made his influence felt as a member.

It might be supposed from Guye's mental characteristics, and from the nature of his studies, that he would have little sympathy with the technical applications of chemistry. No such surmise could be further from the truth. Although not a professed technologist, he had a considerable knowledge of manufacturing chemistry, and he enjoyed the confidence and esteem of the leaders of chemical industry throughout Switzerland, to whom he was always accessible, and by whom his counsel and advice were highly appreciated. His name will always be associated with the extraordinary development of electrochemical synthesis in Switzerland, to which his lectures and writings largely contributed.

Guye exercised great influence in scientific circles in Geneva, and took a leading part in the organisation of Swiss science. He presided over the Swiss Physical and Natural History Society, was a member of the central Committee of the Helvetic Society of Natural Sciences, and president of the Swiss Chemical Society and of the Council of Swiss Chemistry. In 1903 he established the *Journal de Chimie physique*, in which the greater number of the communications from his laboratory after that year were published, and he was mainly instrumental in placing *Helvetica Chimica Acta*—now the leading chemical journal in Switzerland—upon a sound and permanent foundation.

Guye's merits as a man of science were widely recognised. He was a member of the Scientific Academies of Petrograd, Madrid, and Bucharest, an honorary member of the Chemical Societies of France and England, a corresponding member of the French Institute, and a foreign associate of the Reale Accademia dei Lincei, and he shares with his countryman Marignac the honour of being a Davy medallist of the Royal Society. To the great regret of his many friends in England, the illness which ended in his death prevented him from coming to London to receive the medal in person.

He has another association with the memory of Davy, who died at Geneva, which British chemists will not forget. They are grateful to Guye for his pious care of the tomb which holds the remains of the great chemist.

T. E. THORPE.

PROF. W. B. BOTTOMLEY.

PROF. WILLIAM B. BOTTOMLEY, Emeritus Professor of Botany at King's College, University of London, died at Huddersfield on March 24, aged 58, after a long and trying illness which began in April 1918 with a seizure resulting from thrombosis. During the four succeeding years these seizures returned at intervals until the end.

Prof. Bottomley was born at Apperley Bridge, Leeds, on December 26, 1863, and was educated at the Royal Grammar School, Lancaster, and at King's College, Cambridge. He then studied at Heidelberg, where he received the Ph.D. degree. He was lecturer in biology at St. Mary's Hospital from 1886 to 1891. In the latter year he was appointed professor of biology at the Royal Veterinary College, and at the same time served as assistant in botany to Prof. Oliver at University College, London, and as a Cambridge University Extension lecturer. In 1893 he was appointed to the professorship of botany at King's College, London, which post he held until his resignation in 1920.

In 1905 Prof. Bottomley made a journey round the world in connection with University Extension work. He did a great deal of extra-mural lecturing under various auspices, and was well known as an excellent lecturer before either a scientific or a popular audience.

Prof. Bottomley's chief scientific interests were in connection with plant nutrition and the relation of these problems to agriculture. Towards the end of the nineteenth century he actively concerned himself with various co-operative agricultural movements, such as the Agricultural Banks Association and the English Land Colonisation Society. He was a man of great enthusiasms, and it is much to be regretted that he was unable to complete the important work with which his investigations were concerned. His name will always find a place in the history of plant nutrition, along with those of Boussingault, Lawes, and others. His most important contribution to the subject of plant nutrition was probably the discovery of what he called auximones, or growth-promoting substances, in materials such as peat which had been subjected to the action of nitrifying bacteria. The acidity of the raw peat had first to be neutralised by the action of ammonifying organisms. Experiments at Kew and the Imperial

College of Science, as well as King's College, showed that a striking increase in growth occurred when small amounts of this bacterised peat were added to the soil. This led to the chemical fractionation of such treated peat, the extract being used to test the stimulus to growth of the aquatic plant Lemna, and other plants, in culture solutions. It was found that 368 parts per million added to the culture solution gave in six weeks an increase in weight of 62 times the control plants. Other equally remarkable results were obtained. Various papers on the subject were published in Proc. Roy. Soc. and the *Annals of Botany*.

The method was patented, and in the early years of the war great hopes were entertained that peat deposits in many parts of the world could thus be made of direct service in stimulating food crop production. The controversies to which this commercialising of the process led, together with the loss of a son in the war, no doubt contributed to Prof. Bottomley's subsequent breakdown.

The discovery of auximones will remain a landmark in the long history of plant nutrition. These substances differ from vitamines in that they will withstand a temperature of 150° C., while the latter are largely destroyed by boiling. Moreover, unlike vitamines, auximones apparently have no effect on animals. They are probably derivatives of nucleic acid, and appear to be generated in soils through the activity of soil bacteria. Their presence indicates that these bacteria stand in somewhat the same relation to plants that plants do to animals; for the auximones appear to be bacterial products stimulating plant growth, while the vitamines are plant products which are essential for healthy animal development.

It is greatly to be hoped that these remarkable growth-stimulating substances can be isolated, their composition determined, and the method of their production standardised. They would then be of the utmost value to agriculture.

Prof. Bottomley was a member of the Council of the Royal Botanic Society, Regent's Park, where some of his experiments were carried out. He leaves a widow and two sons at Huddersfield, where the family removed from Hampstead a few months before his death.

R. R. G.

Dr. H. N. Dickson, C.B.E.

Henry Newton Dickson, born in Edinburgh in 1866, studied at the University of Edinburgh and came under the influence of the remarkable activities in experimental physics, meteorology, and oceanography directed by P. G. Tait and G. Chrystal in the University and by A. Buchan and John Murray outside. Like many other Edinburgh students of the later 'eighties of the last century Dickson seized the opportunity of acting as volunteer assistant in the work of the *Challenger* Commission, the Scottish Marine Station, and the Ben Nevis Observatory, and by this practical training in physiography he was fitted to take up the reviving study of geography on a basis of sound physical science. Thus, while his researches dealt exclusively with the special fields of meteorology and oceanography, his appointments were mainly in the teaching or the application of geography in its wider aspects.

In 1891 Dickson was engaged at the Marine Biological Association's laboratory at Plymouth in investigations on the salinity and temperature of the English Channel, and on his removal to Oxford in 1893 he extended this work to the whole surface of the North Atlantic. The water-samples were obtained by the officers of Atlantic liners and analysed by Dickson in the University chemical laboratory. It took several years to bring the methods of collection and discussion to perfection, and finally, with the co-operation of the Meteorological Office, Dickson produced his most important work, "The Circulation of the Surface Waters of the North Atlantic Ocean," which appeared in the Philosophical Transactions for 1901, and included monthly maps of temperature and salinity for the two complete years 1896 and 1897. This won him the Oxford D.Sc. degree in physical geography.

At Oxford Dickson joined the lecturing staff of the School of Geography and was very successful as a teacher. He moved to Reading in 1906, where he acted as professor of geography in the University College until 1920. During the war he gave practically his whole time to work at the Intelligence Division of the Naval Staff, where, amongst other duties, he undertook the preparation of an important series of handbooks descriptive of regions in which military operations were being carried on or where they might occur. For this he was decorated with the C.B.E.

In 1893 Dr. Dickson published a small volume on "Elementary Meteorology," which showed originality in conception and presented the principles of weather study in a very attractive form. This was followed in 1912 by a little book on "Climate and Weather," which was equally happy. He also wrote a book on "Maps and Map Reading." Dickson devoted much time to the study of underground water in the chalk formations near London, and the outbreak of war interrupted a most important investigation on which he was engaged with regard to the evaporation from an exposed water-surface. For this purpose he devised an automatic recording evaporimeter, which, so far as can be ascertained, was never made available for general use.

For many years Dr. Dickson was regular in attending the meetings of the British Association, acting as Secretary and Recorder of Section E, and in 1913 he was President of the Section. He was also a member of Council of the Royal Meteorological Society for many years and was President of the Society for 1911–1912.

His last work was in the Editorial Department of the additional volumes of the "Encyclopædia Britannica" for the 12th edition. Into this, as into all his other work, he threw his whole heart, and probably the most remarkable feature of his character was his indefatigable energy in whatever he undertook. He was married in 1891, and leaves a widow, a son in the Royal Navy, and a daughter.

H. R. M.

We much regret to learn from the Lister Institute that Mr. A. W. Bacot, head of the department of entomology, died at Cairo from typhus on April 12.

Current Topics and Events.

No British statesman of our times is more closely associated with scientific activities, or has done more to promote scientific interests, than Sir Arthur Balfour, upon whom the King conferred the honour of knighthood a few weeks ago and invested him with the insignia of the Order of the Garter. We notice, therefore, with much satisfaction the announcement that the King has been pleased to approve that the dignity of an Earldom of the United Kingdom be conferred upon him. Sir Arthur Balfour was elected a fellow of the Royal Society in 1888 and was president of the British Association at the Cambridge meeting in 1904. He has been Lord Rector of St. Andrews University and of Glasgow University, is Chancellor of Edinburgh University, and in 1919 he succeeded his brother-in-law, the late Lord Rayleigh, as Chancellor of Cambridge University. He is president of the British Academy, and Lord President of the Council, and by the latter office is concerned with the Department of Scientific and Industrial Research, in the work of which he takes active interest. Sir Arthur Balfour possesses a sure faith that no attempt to acquire and improve knowledge is vain, and a reasoned belief in the power of science to help and elevate mankind. He is a peer among philosophers and a trusted leader among statesmen, and the honour which has now been conferred upon him has given particular pleasure to all who work for social, intellectual, and scientific progress.

THE retirement is announced of Sir I. Bayley Balfour, Regius Keeper of the Botanic Garden at Edinburgh, Regius Professor of Botany in the University there, and King's Botanist for Scotland. Sir Bayley Balfour succeeded Dickson as Regius Keeper in 1888 and soon initiated that enlightened policy of friendly co-operation between the Commissioners of Works and the Regius Keeper which prevailed throughout his tenure of office. He placed the garden in the unique position it occupies to-day, and made it fruitful of result to botany and horticulture. His strength as Regius Keeper lay in more than one direction, and we may safely place his lovable human qualities and his knowledge of men in the centre of the arch, with his broad-minded, scientific outlook on one side and practical knowledge of horticulture on the other. As an administrator, his knowledge of men and affairs was never exhibited to better purpose than in the happy relations he established with one after the other of a succession of official chiefs who rightly trusted him implicitly. It is scarcely necessary in these columns to refer to Sir Bayley Balfour's position as a scientific botanist, but there is still much for him to do along lines of research he has made peculiarly his own, such, for example, as the differentiation of the great Rhododendron genus, by the characters of the leaf indumentum. As a practical horticulturist, he stands alone in the profundity of his knowledge of plants and their ways. Of late years, taking up the work where Franchet left it in 1900, he has taken the leading part in this country in the enumeration of the discoveries which have been going on for 40 years in the flora of the Western Chinese Alps, and which, in Rhododendron alone, far transcend the epoch-making results of Hooker's exploration of the Eastern Himalaya in the 'fifties. The consideration of the material already to hand, in the discovery of which George Forrest, an old member of the Edinburgh garden staff, has latterly played a major part, has resulted in the publication of a series of invaluable monographic "Notes" on Rhododendron, as well as Nomocharis, Chinese Gentian and Primula, all couched in the lucid style with which many previous publications of Sir Bayley Balfour's have made us familiar.

THE King, on the recommendation of the Secretary for Scotland, has approved the appointment of Mr. W. W. Smith to succeed Sir I. Bayley Balfour as Regius professor of botany in the University of Edinburgh, Regius Keeper of the Royal Botanic Garden, Edinburgh, and King's Botanist in Scotland. Mr. Smith has been assistant to the Regius Keeper for several years.

SIR HUMPHRY ROLLESTON has been elected president of the Royal College of Physicians of London.

SIR F. W. DUKE, Under-Secretary of State for India; Sir Berkeley G. A. Moynihan, professor of clinical surgery, University of Leeds; and Sir Ronald Ross, have been elected members of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public services."

THE latest news from the Mount Everest expedition reports an uneventful march from Darjeeling through Sikkim and over the Jelepla pass into Tibet. The road then lay along the Chumbi valley to Phari Dzong, to which place stores and grain had been despatched in advance. Gen. Bruce reports that on April 8 the expedition left Phari Dzong for Khimbajong. A message from the Pope wishing the expedition success was received before leaving Darjeeling.

ON Tuesday next, April 25, Sir Arthur Keith will begin a course of three lectures at the Royal Institution on "Anthropological Problems of the British Empire." Series II. "Racial Problems of Africa"; on Thursday, April 27, Prof. E. H. Barton will deliver the first of two lectures on (I.) "The Resonance Theory of Audition," (II.) "A Syntonic Hypothesis of Colour Vision"; and on Wednesday, April 26, and Saturday, May 6, Prof. D. H. MacGregor will deliver two lectures on "Industrial Relationships"—(I.) "The Historical Interpretation," (II.) "The Problem of Structure." The Friday evening discourse on April 28 will be delivered by Dr. Arthur Harden on "Vitamin Problems," and on May 5 by Dr. M. Grabham on "Biological Studies in Madeira."

THE special arrangements for Easter made by the French Physical Society include an address by Prof.

P. Weiss on the Strasbourg Physics Institute on Wednesday, April 19, and one by Sir E. Rutherford on the artificial disintegration of the elements on the following day, both delivered in the physics theatre of the science faculty of the University of Paris. On Friday a visit is to be paid to the new wireless station at Sainte Assise where the 2-kilowatt Paris-London station will be seen in operation; the continental 100-kilowatt station is just about to begin work, and a transcontinental station of 1500 kilowatts is being constructed. On the Thursday and Friday there will be an exhibition of apparatus at the rooms of the Society. At this exhibition British scientific apparatus makers have a joint exhibit. A number of French instruments not well known in this country will be displayed, as for example the Yvon spectrophotometer, a direct-reading micro-balance, and several wireless telegraphic appliances.

The second triennial meeting of the Astronomical Union will be held at Rome on May 2–10. The opening address by the president, M. Baillaud, will be delivered at 3 P.M. on May 2, at the Reale Accademia dei Lincei. The following are some of the proposals on the agenda paper: to make simultaneous observations of the variation of solar radiation, including the ultra-violet rays; to endeavour to expedite the completion of the astrographic catalogue; to organise observations of stellar parallax; to open a variable-star bureau at Lyons in collaboration with that at Harvard; to use plates sensitised for the infra-red in order to extend the spectral range and possibly to discover stars hitherto invisible; to organise the re-reduction of older star-catalogues, with a view to proper-motion determinations; to make arrangements for observing the near approach of Eros in 1931; and calendar reform. The Municipality of Rome will receive the delegates on May 4 and they are invited to Florence at the close of the meeting. Visits to Messina, Stromboli, and Etna have also been arranged. Prof. A. Fowler, Royal College of Science, South Kensington, is the General Secretary, and it may be mentioned that Messrs. Cook have arranged on favourable terms for a party leaving London on April 29, and returning on May 13.

The council of the Institution of Civil Engineers has made the following awards for papers read and discussed during the session 1921–22: Telford Medals to Sir Henry Fowler (Derby), Mr. H. N. Gresley (Doncaster), and Dr. H. F. Parshall (London); a Watt Medal to Mr. W. Willox (London); an Indian Premium to Mr. F. G. Royal-Dawson (London); Telford Premiums to Mr. A. W. Rendell (Bournemouth), Mr. W. F. Stanton (Chile), and Mr. A. C. Walsh (Chile). The council has also made the following awards for papers printed without discussion in the Proceedings for the session 1920–21: A George Stephenson Medal to Mr. J. H. Taylor (Buenos Aires); Telford Premiums to Mr. F. H. Hummel (Belfast), Mr. E. J. Finnan (Belfast), and Dr. Herbert Chatley (China); and a Trevithick Premium to Mr. G. E. Lillie (Reigate).

A paper by Sir Robert Hadfield, communicated to the Institution of Civil Engineers on April 4, represents the beginning of a very extensive and important research on the corrosion of ferrous metals which forms part of an inquiry, undertaken by the Institution in 1916, into the deterioration of structures exposed to sea action. It is proposed to place a large number of specimens of iron and steel, 1330 in all, in positions in which they will be exposed to the action of sea water under certain definite conditions. The present paper describes the metals selected for these tests, and gives full particulars of their mechanical properties, chemical analysis, and microstructure. In such an elaborate investigation it is obvious that every care should be taken to determine the exact conditions under which a test is made, and with this object in view special efforts have been made to define the properties of the test-pieces as accurately as possible. The materials selected include pure varieties of iron (wrought and Armco irons), mild and medium carbon steels of several kinds, steels containing copper, nickel, or chromium as a means of lessening corrosion, and cast irons. An ingenious system of numbering has been adopted, so that specimens can be identified even in the case of considerable corrosion taking place. The actual tests will necessarily occupy a long time, and will be supplemented by laboratory investigations. The paper concludes with a review of some of the problems and theories of corrosion, and with an estimate of the annual wastage of iron-steel through corrosion. For the whole world this loss is estimated to be 29 million tons, and the cost, after making allowance for protection, to be in the neighbourhood of 700 millions sterling.

In the March issue of *British Birds* the editor, Mr. H. F. Witherby, gives an account of the progress of the bird-marking scheme during the year 1921. The number of birds "ringed" during the period was 8997, the greatest total for any year since 1914, and the grand total for the thirteen years of the inquiry has reached the remarkable figure of 105,435. The best figures for individual species are those for the black-headed gull and the song-thrush, of each of which more than 11,000 have been marked since the inquiry began. The whole represents a noteworthy achievement, on which Mr. Witherby and his co-operators are greatly to be congratulated, and further important contributions to our knowledge of bird-migration are certain to result from the continuance of the work on this scale. Reference is made by Mr. Witherby to a useful discussion which has recently been going on in the pages of the magazine as to the future development of the inquiry. On the one hand, there are arguments in favour of concentration of effort: larger numbers of certain of the more interesting and "remunerative" species might be marked, and the results would be augmented in value if there were large series of recovery records relating to homogeneous or comparable marking groups. On the other, the opportunities presenting themselves to the majority of co-operators in the inquiry are for promiscuous marking, and these markers might merely be hampered by any attempt at restriction. An account of

some of the results of this inquiry was included in the article on "The Migration of British Swallows" in Nature of March 16.

The Ministry of Agriculture announces that bees can now be examined for the presence of the Acarine Disease on payment of a fee of 2s. for each sample submitted. Live bees only must be sent, and about 30 specimens should be taken from off the combs and packed in a small cage or box provided with ventilation-holes. A piece of muslin should be fastened across the inside for the bees to cling to during transit. A supply of candy sufficient to last for a few days, or a lump of sugar moistened with water, should be wrapped in muslin and fastened firmly to the inside of the box. The latter should be addressed to the Ministry of Agriculture, 4 Whitehall Place, London, S.W.1, and the name of the sender should be written on the reverse side of the label, but crossed through to prevent an error in transit. The remittance should be sent under a separate covering letter with as much information as possible concerning the bees. Payment must be made by postal order or cheque.

On March 22 at a meeting of the Institution of Aeronautical Engineers a paper was read by Mr. Manning on "Seaplane Design," and on March 31 Mr. H. P. Folland dealt with the subject of aircraft design generally. The programme of future fixtures includes papers by Captain Sayers on "Some Unsettled Problems of Aeroplane Design" and by Major Hume on "The Seaplane's Place in Aviation." Visits have been arranged to the works of the De Haviland Aircraft Company, Simms Motor Units Ltd., the National Physical Laboratory, the South Kensington Museum, and the Croydon Aerodrome. The secretary is Mr. L. Howard Flanders, 60 Chancery Lane, and the president, Col. J. T. C. Moore-Brabazon, M.P.

We have received from Messrs. Baird and Tatlock, of Cross Street, Hatton Garden, a copy of their new (1922) catalogue of apparatus for use in physiological and other laboratories where similar apparatus is required. The worker will find it a very valuable and an almost complete list of the instruments at present available for teaching and research purposes. In the latter case, it frequently happens that new apparatus has to be designed and fitted up to solve new problems; but the list sent to us will be of much assistance in giving information of what is actually to be obtained for the purpose in view. We note that the collaboration of physiologists has been obtained in the selection of the material to be included and the presence of apparatus for physico-chemical measurements is to be welcomed. The instruments for convenient measurement of electrical conductivity and potential have been somewhat difficult to obtain in recent years in England. The prices on the whole appear to be reasonable.

Our Astronomical Column.

The Shower of Lyrids.—These meteors may be expected to return on the night of April 21, and as the moon will be absent this year at the time of the maximum display, they should be well observed. The best hour at which to witness the event will probably be near midnight, for in the morning hours on April 22 the earth is likely to have passed through the denser part of the stream. The shower certainly lasts ten days, but it appears in its most active stage for a short period only. Of late years the meteors of this system have not been visible in striking abundance, and it is an unfortunate circumstance that its period of revolution is unknown. A brilliant exhibition of the meteors may occur in any year, and quite unexpectedly as in 1803 and 1851.

The Position of Neptune's Equator.—It has long been known that the plane of the orbit of Neptune's satellite Triton is changing its position. The only probable cause is the oblateness of Neptune, and it follows that the orbit plane makes a considerable angle with the planet's equator. By plotting out the poles of the satellite's orbit at different epochs we get an arc of a small circle, the centre of which is the pole of Neptune's equator. The latest determination of the position of the latter pole is that made by Mr. Arthur Newton (*Pop. Ast.*, March 1922). Making use of 1500 observations of the satellite, made from 1864 to 1908, he gives R.A. 19 h. 17 m., N. Decl. 38°·3 as the northern end of Neptune's axis. The pole of the satellite's orbit describes a circle round this, of radius 14°·7, in 425 years. There is little doubt that Neptune's rotation is retrograde; this has been verified for Uranus by the spectroscope, the period of $10\frac{3}{4}$ h. being found at the same time. In the case of Uranus the equator evidently coincides with the orbit planes, since these are all practically coincident and no change in them has been detected.

Determination of Star Magnitudes by a Thermopile.—J. Schilt has devised a new method of determining photographic star-magnitudes, which he describes in Bull. No. 10 of the Astr. Inst. of the Netherlands. The light and heat from a lamp are focussed by a lens on a small circle of the plate, which is somewhat larger than any of the star-images; these images are then moved in succession into the circle of light, and the amount of heat absorbed by the image is measured by the galvanometer of the thermopile. The process is rapid, the equilibrium temperature being attained in three seconds. The probable error, deduced by comparing the measures of two exposures on the same plate, is found to be 0·02 mag., whereas that from the method of diameter of image is 0·11 mag.

The most striking advantage of the new method is that it gets rid of practically all error due to variation in the shape of the image with varying distance from the centre of the plate. It also gets rid of the error that arises in the star diameters in plates taken with a refractor, due to the chromatic aberration which depends on the star's colour. In fact the method appears to give the integrated amount of darkening of the film independently of the size or shape of the image. This is verified by the application of the method to some of the polar plates taken with the 60-inch reflector at Mt. Wilson. The tables show that it gives good results up to a distance of 44 mm. from the centre of the plate, whereas Seares had found that the diameter method needed corrections of about half a magnitude at a distance of only 20 mm. The method would seem to have a large field of usefulness in the photometry of faint stars on reflector plates.

Research Items.

THE ICE AGE AND MAN.—In the January and April issues of *Man*, Messrs. H. J. E. Peake and J. Reid Moir have published schemes correlating the palæolithic types of culture with the geological strata. The conclusions proposed by both writers agree fairly, except that in Mr. Reid Moir's scheme the position of the Alpine glaciations has been moved up one stage. On this Mr. Peake remarks: "According to Mr. Reid Moir the Mousterian straddles the Riss, while Obermaier has argued with much force that it straddles the Würm, and the Magdalenian immediately precedes the Würm, while Penek and Schmidt have shown that this phase extended into the Bühl. This divergence seems to require some explanation."

RUSH AND STRAW CROSSES.—Rude bundles of straw or rushes, in the form of crosses, are often found hung over the doors in many parts of Ireland on St. Brigid's Day, the February festival marking the end of winter and the beginning of spring. Miss E. Andrews, who discusses the question in the April issue of *Man*, with a good illustration, suggests their connection in form with the Swastika, and infers that we have in them a very ancient symbol used in pagan times to represent the sun emerging from the darkness of winter. This ingenious explanation is supported by a certain amount of evidence, and it deserves consideration.

ANIMALS ON THE ROOF.—In the March number of *Folk-lore*, Prof. H. J. Rose of University College, Aberystwyth, attempts to explain a passage in Petronius where Trimalchio speaks of Asinus in Tegulis—the portent of an ass appearing on the tiles. He brings together a number of examples showing that in the lower culture the appearance of an animal or a bird on the roof is regarded as portentous. This leads to the consideration of the roof in connection with beliefs regarding the house. He suggests that in the case of Trimalchio's ass the animal may have been conceived as an evil spirit or a new and particularly disagreeable form of ghost. The uncanny effect of fire-light on the rude thatching and the smoke-wreaths, the strange scratchings and patterings of small nocturnal animals running over the top of the hut, nightmares in which the roof threatens to fall and crush the sleeper, real injuries from the collapse of the flimsy structure, the intrusion of beasts of prey, bats, moths, and small birds fluttering about inside—all these and many other factors may well have united to make up the sum of this curious chapter of folk-belief.

CYTOPLASMIC INCLUSIONS OF THE GERM-CELLS.—The discovery of the chromosomes and their behaviour both in ordinary cell-division and in the maturation of the germ-cells opened up a new era in the study of the mechanism of heredity, and it is now widely believed that the chromosomes are the bearers of "factors" or "genes" that are responsible for the transmission of heritable peculiarities. In recent years, however, a good deal of attention has been paid to certain structures, the "mitochondria" and "Golgi apparatus," that occur in the cytoplasm, outside the nucleus, and it has been suggested that the mitochondria, at any rate, may constitute the protoplasmic basis of heredity. In the current number of the *Quarterly Journal of Microscopical Science* (vol. 66, part 1) Prof. J. Brontë Gatenby concludes his notable series of memoirs on "The Cytoplasmic Inclusions of the Germ-cells," and expresses the opinion that "As direct bearers of any important or precise factors of heredity, the Golgi body and mitochondria appear to be ruled out by their inexact and variable behaviour in the germ-cell cycle. The chromosomes, and the chromosomes alone, fulfil the necessary conditions."

ENTERONEPHRIC EXCRETORY ORGANS IN EARTHWORMS.—A few years ago a remarkable "enteronephric" system of excretory organs in Pheretima was described by Dr. K. N. Bahl, consisting of modified nephridia which open by a system of ducts into the alimentary canal, instead of opening on the surface of the body as in the usual (integumentary) type. The system consists of septal and pharyngeal nephridia. It was a matter of considerable interest to determine whether these modified nephridia are formed from the epiblast of the embryo, like ordinary nephridia, or whether they develop in some other way. Dr. Bahl has now investigated this problem and gives in the *Quarterly Journal of Microscopical Science*, vol. 66, Part 1, a detailed embryological account of the organs in question, as well as of the integumentary nephridia of the same worm. He finds that all three types can be traced back to the original epiblastic row of nephridial cells. The connection of the enteronephric system with the alimentary canal is evidently a secondary feature that has arisen comparatively late in phylogeny.

THE EFFECT OF TEMPERATURE ON THE ABSORPTION SPECTRA OF GLASSES.—The observations of Houstoun on the absorption spectra of eight or nine kinds of coloured glass showed in 1906 that, while in most cases an increase of temperature from 15° C. to about 330° C. produced in the visible spectrum an increase in the absorption on the longer and a decrease on the shorter wave length side of an absorption band, this was not invariably the case. Nor was the absorption in all cases decreased by increase of temperature. Gibson in 1916 investigated five glasses at −180° C. and 430° C. in the visible part of the spectrum, and found in some cases, as for instance that of a red glass, that the absorption for a particular wave length increased at the higher temperature to fifty times its value at the lower. In a Ph.D. thesis of the University of Pennsylvania recently issued, Mr. G. Rosengarten describes his measurements of the absorption of a number of coloured glasses in the infra-red between wave lengths 1 and 5×10^{-4} cm. His source was a tungsten lamp, his spectrometer prism of rock salt, and the issuing radiation was measured by a thermo-pile. Up to 500° C. he finds the changes in absorption seldom exceed the instrumental error of 8 per cent.

COLOUR SENSITIVE PHOTOGRAPHIC PLATES.—We have received from the Bureau of Standards, Washington, a copy of a communication entitled "Studies in Colour Sensitive Photographic Plates and Methods of Sensitising by Bathing," by Francis M. Walters, Jr., and Raymond Davis. The authors describe their methods of investigation, and deal with pinacyanol in considerable detail. They have also investigated the use of dicyanin, erythrosin, pinaverdol, pinachrome, orthochrome T, and homocol, as well as the hypersensitising of commercial panchromatic plates. They find that the various dyes require different methods for their most successful application. The previous washing of the plate to be treated is sometimes of great importance, and the effects of alcohol and of ammonia need, perhaps, more attention than they have hitherto received. The paper is well illustrated. It is ready for distribution and any one interested may obtain a copy from the Bureau until the free stock is exhausted.

A Unique Long-period Variable Star.

By Major W. J. S. Lockyer.

SINCE the year 1811 the star designated R. Aquarii (position for 1900 Right Ascension $23^h\ 38{\cdot}6^m$, Declination $-15°\ 50'$) has been known as a variable star. It goes through a complete cycle of variability in 385·5 days, attaining a maximum brightness of 6·2 and a minimum of 11·0.

This star, like about 85 per cent. of all long-period variables, has a spectrum of the class Md, *i.e.* a spectrum showing bright hydrogen lines and numerous absorption flutings of titanium-oxide on a continuous spectrum, and indicative of comparatively low temperature.

Fig. 1.—Nebulosity around R. Aquarii.
Photographed by C. O. Lampland, Lowell Observatory.

On October 16, 1919, Mr. Paul W. Merrill, using the 100-inch reflecting telescope of the Mount Wilson Observatory, discovered that several other bright lines, characteristic of gaseous nebulæ, were present. This made the spectrum unique, because while there is considerable evidence to connect hot stars, such as Class O or Wolf-Rayet Stars, with gaseous nebulæ, there was no instance, prior to this, in which a comparatively cool star is associated with the nebulæ.

A further interesting observation that has been made is that while the nebular lines remain almost constant in intensity throughout the light changes of the star, the other lines representing the Md spectrum vary through a large range. This suggests that the star and nebula are independent of one another: other observations on the other hand tend to show a close connection between the two.

The most recent discovery relating to this star is of extreme importance, for it is now known that the star is in the centre of a mass of nebulous matter.

The photograph showing this was taken by Mr. C. O. Lampland with the 40-inch reflecting telescope of the Lowell Observatory. This nebular image he describes as an oval-shaped, elongated configuration composed of arcs of well-defined nebular filaments and the star is centrally and symmetrically placed. The position-angle of the longer axis of the formation is about 90° and the greatest extent of the faint structure in this direction is a little more than two minutes of arc. Mr. Lampland has forwarded a positive photograph on film from which the accompanying illustration (enlarged twice) has been made. On his photograph 1 mm. represented 24·5 seconds of arc (approx.).

The general form of the nebulosity here displayed is very similar to that of the nebula N.G.C. 5921. This latter is reproduced on Plate I. in vol. xiii. of the "Publications of the Lick Observatory," and is given there as an example of what Mr. H. D. Curtis calls a ϕ-Type Spiral Nebula.

The actual presence of this nebulosity is of great value in accounting for the unique character of the star's spectrum. Attention must also be directed to the importance of long-exposed photographs with powerful reflectors for the purpose of searching for nebulosities whenever nebular lines appear in a spectrum. It will be remembered how such lines, appearing in the spectra of novæ in the later stages of their career, led to the discovery of the presence of nebular matter surrounding the star.

Marine Invertebrates.

FURTHER reports on material collected by the British and Australian Antarctic Expeditions have been received. The Chætognatha of the Australian Expedition have been described by Prof. T. H. Johnston and Mr. B. B. Taylor, systematic accounts of the Crustacea of the British (*Terra Nova*) Expedition are given by Mr. R. W. Barney on the Ostracoda, and on the Tanaidacea and Isopoda by Dr. W. M. Tattersall. Dr. H. M. Woodcock and Miss Olive Lodge describe the collection of parasitic protozoa, which consists of only three species—a new species of the flagellate genus Cryptobia, a new species of Gregarine (Selenidium), and a ciliate. This ciliate, for which a new genus (Hæmatophagus) is created in the family Stentoridæ, is parasitic on the baleen plates of the humpback whale, and feeds exclusively on the whale's red-blood corpuscles. It reaches a length of 1-1·5 mm., and secretes a delicate transparent tube, up and down which it moves; when feeding the oral end of the ciliate may project from the tube. The red-blood corpuscles are directed into the mouth by the adoral zone of strong cilia fused into membranellæ, pass into the protoplasm, and become enclosed in food-vacuoles. The larger vacuoles may contain numerous corpuscles which become compressed, and, owing to the dissolution of the envelope of the corpuscles, the hæmoglobin-containing substance of all the red cells in the vacuole merges into one homogeneous mass. As digestion proceeds the vacuoles pass gradually backwards, and pigment—agreeing in appearance with melanin—is formed on the outside of the vacuole. Hæmatophagus is unique among ciliates in producing melanin as a result of the digestion of hæmoglobin. This pigment tends to accumulate in the hinder half of the body, and the authors find evidence that when the organism is full-grown the pigment is got rid of by casting off that portion of the body prior to the commencement of the resting, multiplicative phase. How the blood of the whale becomes available to the ciliate has not been established.

Mr. C. H. Edmondson gives (Occasional Papers, Museum of Polynesian Ethnology and Natural History, Honolulu, 1920) a short account of the edible mollusca of the Oregon coast. These are all bivalves; some, belonging to the genera Siliqua and Mya, are

known locally as "clams" of various kinds, and there also occur two species of Mytilus, a pecten, a cockle, and an oyster. The Indians made extensive use of these molluscs before the advent of the white man on this coast, as is shown by the great heaps of shells still remaining. *Mya arenaria*, which was transported from the Atlantic coast many years ago, probably with oyster-spat, has become well-established in many localities on the Pacific coast, where it inhabits the mudflats of bays and has advanced up some estuaries, always remaining, however, within the influence of salt water. The author records that in January, 1918, excessive rainfall caused exceedingly high water in one of these estuaries, the Mya being washed with comparatively fresh water for four weeks, and at the end of the period a dense layer of fine sand, up to 2 in. in depth, covered the clam bed. A high percentage of the younger and weaker individuals was found to be dead, probably smothered by the fine silt. Mya is found to withstand transportation to inland markets if kept at a low temperature, and will remain in good condition for a week after having been taken out of the water, but the other clams cannot be sent successfully any distance in marketable condition. Certain of them are canned at the coast. Observations are given on the spawning periods and growth of the bivalves.

The attention of students of recent Crinoids may be directed to a paper by Dr. Austin H. Clark on "Sea-lilies and Feather-stars" (Smithsonian Misc. Coll., vol. 72, No. 7, 1921). The account, while devoted chiefly to external and skeletal features, includes short notes on regeneration, asymmetry, distribution, food, locomotion, etc.

Water-power Resources of India.[1]

THE Triennial Report (1919–1921) of the Hydro-Electrical Survey of India, which has just been received, is of the character of a comprehensive volume, embodying all the essential information contained in the preliminary and second Reports, which have already been noticed in NATURE. In addition, it contains later information derived from the investigation of certain sites selected for their potential value as sources of water-power supply. In the result, the opinion is formed "as a rough preliminary forecast" that the probable water of India for maximum development is some 12,680,000 kilowatts, equivalent to 21½ million water horse power, of which only 1¼ per cent. so far is developed or in course of development. The estimate is, of course, to be received with caution, as it is largely "speculative and based on the minimum of reliable information." The water power actually developed at the present time amounts to 138,780 kw., (continuous), capable of being expanded to 213,150 kw., in accordance with the ultimate capacity of the sites exploited. The following is a detailed summary of the probable *minimum* continuous water power:—

	Kw.
Assam	414,000
Baroda	4,000
Bengal	669,850
Bihar and Orissa	62,550
Bombay	644,310
Burma	951,570
Central India	680
Central Provinces and Berar	137,560
Cochin	4,000
Coorg	1,500
Gwalior	43,300
Carry forward	2,933,320
Brought forward	2,933,320
Jammu and Kashmir	305,330
Madras	92,310
Mysore	48,500
North-West Frontier	1,000,000
Patiala	290
Punjab and Canals	793,150
Rajputana	160
Sikkim	5,000
Travancore	450
United Provinces and Canals	403,370
	5,581,880

The Survey is being made under the supervision of Mr. J. W. Meares, who was appointed Chief Engineer in succession to Mr. F. E. Bull. It is noteworthy that the same reluctance to finance hydrographical surveys exists in India as in other parts of the Empire. Mr. Meares is much concerned as to the outlook. As a consequence of the "Reforms" made by the Government of India, it was decided in October, 1920, that all outlay on water storage and water power would be a Provincial charge and that the necessary provision for hydro-electric surveys should therefore be made in the Provisional Estimates from and after the year 1921–22. When the Estimates came up for approval before the various legislative councils, in many instances reductions were moved, and as the matter now stands "the Survey is in danger of falling between the upper and the nether millstone, as the Government of India is no longer able to provide funds for a continuance of the work."

A considerable quantity of useful data is incorporated in the volume, including seven plates and maps, 23 diagrams, and 51 tables. Much detailed information is set out for the guidance and direction of those engaged in the Survey, of whose cordial co-operation Mr. Meares speaks very highly.

[1] Hydro-Electric Survey of India. Volume III. Triennial Report with a Preliminary Forecast of the Water Power Resources of India, 1919 to 1921. By J. W. Meares. Pp. ix+199. (Calcutta: Government Printing Office, 1921). 4 rupees.

University Pensions.

THE Sixteenth Annual Report of the Carnegie Foundation for the Advancement of Teaching provides some interesting reading, especially regarding pension systems. The claim is made that in the Reports of the Foundation will be found "the most complete information concerning pensions and pension systems in existence." The remarks on the University Teachers' pensions in England and Wales deserve notice. Reference is made to the movement of the Association of University Teachers to secure the extension of the School Teachers (Superannuation) Act of 1918 to University teachers, or failing this to obtain benefits at least equivalent to those offered by the Act. As in previous years, the Report shows a strong bias against any non-contributory scheme. It is very easy to understand why this should be so. The Teachers' Insurance and Annuity Association of America could not have come into existence on any other than a contributory basis. On its own showing the Foundation was unable to finance a scheme such as is growing up in America. But no attempt is made to demonstrate how such a contributory scheme can be "sounder" than a non-contributory scheme backed by the government of the country. It would

be difficult to do so in face of the existence of the British Civil Service, and the report wisely refrains from the attempt.

In regard to the "problem of transfer" the report is greatly at fault. It is a pity the writer of it did not seek more accurate sources of information or at least endeavour to understand the facts of the case. At the present moment, and for the future unless a change is made, a teacher who "transfers" to a university sacrifices superannuation benefits in whole or in part. This is acting adversely upon the recruiting of university staffs, and will continue so to act unless some attempt is made to obviate this loss. We can assure the writer that the question of transfer from the lower to the higher branches of the profession in this country is a really serious one, and one which is felt especially in the departments of science and technology, as well as in those for the training of teachers. For example, some schools of the University of London come under the Act and others under the Federated Superannuation System, two totally different schemes, and in consequence transfers from one college to another in one and the same university are difficult if not impossible.

It may interest American university teachers to know that the British Government has made a grant of half-a-million towards retrospective benefits ("accrued liabilities") for the senior members of the teaching staffs in the universities—a sum which, by the way, is quite inadequate for the purpose—but for some extraordinary reason has made no provision for retrospective benefits in regard to teaching service in institutions and schools outside the universities. Is there any better way of making watertight compartments of the various branches of the teaching profession?

University and Educational Intelligence.

Cambridge.—Close on the publication of the report of the Royal Commission commending the women's colleges to private benefactors comes the welcome announcement of a bequest to Girton College of 20,000*l*. This money, left by Rosalind, Countess of Carlisle, is earmarked for scholarships of 80*l*. per annum for girl students unable to pay for themselves.

London.—The following doctorates have been conferred:—Ph.D. (Science) on Mr. A. C. Chibnall, for a thesis entitled "The Distribution of Nitrogen in the Leaves of the Runner Bean"; Mr. T. J. Drakeley, for a thesis entitled "The Ultimate Composition of British Coal"; Mr. H. S. Hatfield, for a thesis entitled "On a New Method for the Separation of Mechanical Mixtures of Powdered Substances"; Mr. G. H. G. Plymen, for a thesis entitled "The Geology of Jersey and Alderney"; Thirza Redman, for a thesis entitled "Observations on (Experimental) Intestinal Tuberculosis"; Barbara Russel-Wells, for a thesis entitled "The Constitution of the Cell Wall in Plants, more particularly that of the Red Seaweeds"; and Mr. T. Thomas, for a thesis entitled "The Effect of Stress on the Thermo-Electric Properties of Metal Wires with and without a Magnetic Field."

At University College, Gower Street, W.C., a course of six lectures on the Early History of the Land Flora will be given by Dr. D. H. Scott at 5.15 p.m., on Wednesdays April 26 and May 3, 10, 17, 24, and 31. The lectures will be illustrated by lantern slides.

At King's College, Strand, a course of four lectures on Biological Aspects of Oceanography will be given by Dr. Johan Hjort (of the University of Christiania) at 5.30 p.m., on April 28, May 1, 2, and 5. The lectures will be delivered in English.

At Bedford College for Women, Regent's Park, a course of three lectures on "L'Intelligence et la Volonté" will be given by Prof. E. Claparède (professor of psychology in the University of Geneva) at 5.15 on April 28, May 1 and 2. The lectures will be delivered in French. Admission to all these lectures is free without ticket.

Two Munitions Committee Fellowships in research in engineering are offered by the University of Liverpool. The fellowships are tenable in the first place for one year, value 250*l*. each, but may be renewed for a second year when their value will be 350*l*. each. Forms of application and all particulars may be obtained from the Registrar of the University. Applications for the fellowships must be received before June 1.

Some interesting summaries are provided in *Science* of March 17 showing the number of doctorates in science conferred by American universities in the year 1920–1921, and their distribution according to subject. In all, 332 doctorates in science were conferred by 32 institutions, an increase of nine on the corrected figures for the previous year; with one exception, they were distributed over the same universities. In spite of the increase, the number still falls far short of the maximum, 372, recorded for 1917. As has been the case for several years past, the biggest number, 42, was awarded by the University of Chicago, though Cornell, Columbia, Yale, Harvard, California, and Johns Hopkins Universities all conferred more than 20 doctorates each. Chemistry has, since 1912, claimed a great many more doctorates than any other subject, and in 1921 it seems to have been more popular than ever; no less than 134 doctorates of the total of 332 were given for this subject while the next highest figure is 36, the number of doctorates awarded for zoology. Botany, physics, and psychology were each of them the subjects of the theses of 25 to 30 doctorates.

On Monday, April 24, Dr. Malinowski, the well-known Polish sociologist, will deliver at the London School of Economics the first of a course of eighteen lectures on "The Sociology and Economics of Some Island Communities." This course of lectures embodies the results of an investigation of four years' duration in the course of which Dr. Malinowski made an intensive study of the culture of the Papuo-Melanesian communities on the coastal mainland and on the archipelago around the eastern end of New Guinea and more particularly of those of the Trobriand Islands. The complex economic system, of which Dr. Malinowski has already given some account in a previous course, will be analysed, and the remarkable manner in which their intricate economic system permeates their whole life will be described. In this field of investigation, Dr. Malinowski's results were not only unexpected, but they threw an entirely new light upon certain elements in primitive life. In like manner his investigations have revealed a definite, though rudimentary, legal machinery for the preservation of law and order. The regulation of sex life by taboos has given rise to a mythical cycle and a whole system of love-magic; while sorcery, which plays a large part in the life of the native, is based upon a complex system of auto-suggestion and counter-suggestion. The most significant feature in the material which Dr. Malinowski has collected, is the extraordinary complexity and inter-relation of the elements of native life. On more than one occasion reference has been made to difficulties arising out of this complexity when native custom is modified under European authority. Dr. Malinowski's results, from this point of view, are a strong argument in favour of the institution of a central organisation at which such data as these may be made available for the use of administrators.

Calendar of Industrial Pioneers.

April 20, 1821. Franz Karl Achard died.—Descended from a French protestant family, Achard was born in Berlin, worked at chemistry with Marggraf and became director of the physical department of the Berlin Academy of Sciences. He was a pioneer in the production of sugar from beetroot and in 1801 erected a sugar factory.

April 21, 1819. Oliver Evans died.—Born in Newport, Delaware, in 1755, Evans became a practical miller. He was the author of numerous improvements in milling, and his system was adopted both in America and Europe. He also experimented with high-pressure steam; in 1803 he began building steam engines, and the same year constructed a self-propelling dredging machine.

April 21, 1889. Robert Stirling Newall died.—The inventor in 1840 of iron wire ropes, Newall established works at Gateshead and became famous as a maker of submarine telegraph cables. The first successful cable between Dover and Calais was made by him in 1851, and he constructed half of the first Atlantic cable. He was also known as an astronomer, and presented one of his large telescopes to the University of Cambridge.

April 22, 1833. Richard Trevithick died.—One of the greatest engineers and the most fertile inventors of his day, Trevithick, like Evans, turned his attention to the use of high-pressure steam, constructed double-acting high-pressure engines, and between 1797 and 1808 made important experiments with locomotives. The son of a manager of a mine, Trevithick became chief engineer of some of the mines in Cornwall. In 1813 he erected some of his engines in Peru, where he resided about ten years.

April 22, 1864. Joseph Gilbert Totten died.—Trained as a military engineer at the West Point Academy, Totten rose to be colonel of the Corps of Engineers of the United States, and became known for his researches on the strength of materials and allied subjects, his work on the lighthouse board, and his investigation of New York harbour.

April 23, 1897. Adam Hilger died.—The founder of a firm of scientific instrument makers, Hilger was a native of Darmstadt. After being trained as a mechanical engineer he worked under Ertel in Munich and under Lerebours in Paris and about 1870 came to England. A few years later he set up in business for himself at Islington, becoming well known as a constructor of instruments for celestial spectroscopy.

April 25, 1840. Sir Robert Seppings died.—Master Shipwright at Chatham Dockyard, and then from 1813 to 1832 Surveyor of the Navy, Seppings introduced improved methods of docking and undocking ships, and was the inventor of the system of diagonally bracing and trussing the frame timbers of ships, an innovation of the first importance. He gave an account of his improvements to the Royal Society and was awarded the Copley medal.

April 26, 1893. Edward Alfred Cowper died.—An apprentice of John Braithwaite, Cowper afterwards worked with Fox and Henderson, and was employed on the buildings for the Great Exhibition of 1851. He then became a consulting engineer and was known for his work in connection with the development of the compound steam engine, his invention of the regenerative hot blast stove, and the introduction in 1868 of the modern bicycle wheel with wire-spoke suspension. In 1880 he was elected President of the Institution of Mechanical Engineers.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, April 6.—Sir Charles Sherrington, president, in the chair.—F. E. **Smith**: On an electromagnetic method for the measurement of the horizontal intensity of the earth's magnetic field. A Helmholtz-Gaugain arrangement of coils consisting of two interwoven helices of bare copper wire wound in spiral grooves in a marble cylinder are mounted on each side of the centre. Each coil is of 30 cm. radius, of six turns, and of $1\frac{5}{8}$ mm. pitch. The cylinder is mounted on a non-magnetic base, and can be rotated about a vertical axis. The magnet at the centre is 1 cm. long and about 6 sq. mm. in cross-section; it is supported on a V of aluminium foil by a fine quartz fibre, to which is attached a reflecting mirror and a damping vane. The magnet is easily removed from its support, and a copper wire of equal weight substituted. The axial magnetic field due to the current in the coils is made slightly greater than "H," and its component in the magnetic meridian opposes H. By adjustment of the angle α between the axis of the cylinder and the direction of magnetic north, the indicator magnet is caused to set at right angles to the meridian. When torsion is eliminated, $H = Fi \cos \alpha$, where F is constant of coil system and i is current. A determination of H occupies less than 4 minutes. The probable error, including that due to uncertainty of the value of the current, measured by a current balance, is about ± 4 in 100,000.—G. I. **Taylor**: Stability of a viscous liquid contained between two rotating cylinders. Steady motion of viscous liquid between two concentric rotating cylinders is unstable for symmetrical disturbances, provided the velocity of the system is greater than a certain value, and the ratio of angular velocities of the cylinders is less than the reciprocal of the square of the ratio of their radii, or is negative. The type of instability is periodic along the length of the cylinders, consisting of vortices enclosed in partitions rectangular in section, and they rotate alternately in opposite directions. When the cylinders rotate in the same direction each vortex extends across the space between the cylinders. The length occupied by each vortex is equal to the thickness of fluid between them. When the cylinders rotate in opposite directions, two systems of vortices rotating as though geared together appear. Some criteria for stability in approximate form suitable for numerical computation have been obtained.—T. H. **Havelock**: Dispersion formulæ and the polarisation of scattered light; with application to hydrogen. Simple types of dispersion formulæ are considered when the medium consists of anisotropic molecules distributed at random and having an axis of symmetry. A formula for the corresponding ratio of the intensities of the two polarised components of light scattered at right angles, when the primary light is unpolarised, is given. The case of hydrogen is examined numerically and the ratio of the intensities agrees substantially with Lord Rayleigh's experimental value.—G. R. **Goldsbrough**: The cause of Encke's division in Saturn's ring. A satellite will, from its inclined path alone, produce one new division in the ring system. If the satellite be Mimas, a narrow division closely corresponding to Encke's division is produced. Similarly, Enceladus should produce a division in Ring B, but it would be almost unobservable.—C. **Spearman**: Correlation between arrays in a table of correlations. Correlations between arrays are expressed as functions of the independent variable elements entering into the main variables. When only one element is common

to any different variables, then the correlation between every two parallel arrays amounts to plus or minus unity. The converse is also true. The correlational coefficients considered are derived from product moments and the proofs do not assume any "normal" frequency distributions.—W. L. **Balls**: Apparatus for determining the standard deviation mechanically. The apparatus is related to the "Harp" Harmonic Analyser, similarly utilising separately loaded strings to deflect a yoke upon which they all converge. The design of the yoke has been modified to make the readings quantitative, and each string is loaded in proportion to the square of its deviation from the zero position. A template representing the frequency curve under examination is inserted behind the loaded strings, and the movement of an optical lever gives the "sum of the squares of the deviations." The reading is then transferred to a monograph to complete the calculation. The values obtained are correct to within 5 per cent.

Association of Economic Biologists, March 31.—Prof. E. B. Poulton, president, in the chair.—W. Lawrence **Balls**: The advantages and disadvantages of team work in economic biology. An attempt to enunciate certain principles governing the increasing development of team work between different scientific workers and sciences, particularly on the industrial and economic side. Minor principles: (1) the team leader must administrate research, and not merely administrate; (2) the "scientific management" of scientific research must be considered; (3) every new problem needs a new method. Of major principles, apart from the self-evident essential of sincerity, two are enunciated: (1) The specialist in an applied science must be a "jack-of-all-trades"; (2) the scientific worker's code of "individualism in effort and credit; communism in results" must not be contravened.—F. **Kidd**: Problems of fruit storage. The uses of fruit storage in commerce were described and an outline given of the amounts of fruit imported into this country as compared with what is grown ourselves. Apples, more particularly, were dealt with as one of the most important crops and our backward position in relation to other countries with regard to apple storage pointed out. An account was given of experiments carried out to test the efficacy of gas storage, a cheaper method than cold storage, the possibility of which was first suggested by purely scientific work carried out by the author on the effect of carbon dioxide and oxygen upon germination and growth. Finally, the author dealt with a series of recent experiments upon the respiration of apples during their storage life after gathering. At each of three temperatures tested, 2·5° C., 10° C., and 22·5° C., the rate of respiration changes with age in similar manner, first rising, then falling. The age changes in the respiration curves are, however, not related to the amount of respiration. Apparently, while the respiration rate has a temperature relation of 1 : 2·5 : 8, the age factor has a temperature relation of the order of 1 : 4 : 30, and consequently at analogous points on the age respiration curves more carbon dioxide has been produced at 2·5° C. than at 10° C. or 22·5° C.

Zoological Society, April 4.—Prof. E. W. MacBride, vice-president, in the chair.—R. H. **Burne**: The recessus orbitalis in flat fishes.—L. T. **Hogben**: The influence of pituitary gland in inducing metamorphosis of the Axolotl.—J. T. **Cunningham**: Mendelian experiments on fowls. III. Production of dominant pile colour.—M. **Khalil**: A revision of the nematode parasites of elephants, with a description of four new species.

Linnean Society, April 6.—Mr. H. W. Monckton, vice-president, in the chair.—A. B. **Rendle**: A seedling of the red horse-chestnut (*Æsculus rubicunda*) in which a new terminal bud had been developed to replace the original shoot springing from the seed. The original main shoot, broken some distance below the plumule, was covered after a few days by a new growth which developed into a new terminal bud. The new bud resembled a normal terminal bud the outer leaves of which are imperfect.—L. A. **Borradaile**: The mouth-parts of the shore crab, *Carcinus mænas*. Each of the paired appendages plays a distinct part in manipulating the food. The circulation of the water in the gill-chamber follows a definite course dictated by the arrangement of the organs. The maxillipeds of the third pair of appendages function in feeding, as an operculum, and as cleaning organs.—C. **Turner**: The life-history of *Staurastrum Dickiei*, var. *parallelum* (Nordst.). The contents of the spores of this desmid were, at first, of an oily character. During later stages four nuclei were visible; this apparently indicates that conjugation resulted in a diploid nucleus, and that a reduction division occurred inside the spore before the discharge of its contents. Germination results in the formation of four, three, two, or one desmid only, usually accompanied by an atrophied nucleus in the surrounding protoplasm when the smaller numbers are formed. Conjugation is usually of the normal type, and the zygospores are produced between the two desmids; a conjugation tube was seen in one instance only. The conjugating desmids were asymmetrically placed and the protoplasmic contents indicate a slight differentiation of the sexes. The conjugation of a four-rayed with a three-rayed form is not infrequent, and a four-rayed form may occasionally be seen associated with the three-rayed embryonic desmids in the protoplasm discharged from the same spore, when germination takes place. The vegetative division often occurs by the development of a single circular bulging cell between the two semicells. The contents may divide, or an hour-glass constriction may cause the ultimate formation of two desmids.

PARIS.

Academy of Sciences, March 13.—M. Emile Bertin in the chair.—M. **Hamy**: A property of photographic emulsions and the registration of stars during total eclipses of the Sun in view of the verification of the Einstein effect. It has been found that a short exposure of a photographic plate to light of very feeble intensity, short of producing fogging, increases the sensibility of the plate, so that a plate which just shows a fifth magnitude star before this treatment shows a seventh magnitude star after the preliminary exposure, the time being the same in both cases. The bearing of this on the photography of stars round the Sun during a total eclipse is discussed.—C. **Guichard**: Networks which are harmonic to one C.L. congruence and conjugate to another C.L. congruence.—J. **Andrade**: The mechanical problems of regulating springs in chronometers.—C. **Nicolle** and E. **Conseil**: Preventive vaccination by the digestive tract in man. Experiments on voluntary subjects (Europeans) showed that the dead cultures of organisms secured immunisation in man against Mediterranean fever and dysentery. In the latter, owing to the danger of subcutaneous inoculation, the use of a digestive vaccine offers great advantages.—M. **Lecat**: Abnormal caylians and bicaylians.—K. **Popoff**: The general equation of the elliptic type.—E. **Cartan**: Generalised space and the theory of relativity.—E. **Bompiani**: The geometry of curved spaces and the energy tensor of

Einstein.—M. **Frontad**: Logoids of slipping of soil.—E. **Fichot**: The sense of rotation of cotidal lines round amphidromic points.—M. **Siegbahn**: The degree of exactitude of Bragg's law for the X-rays. Exact measurements have shown that calcite gives a small deviation from Bragg's theory, the differences although small being systematic. M. Dauvillier has recently suggested that the deviation was due to the complexity of the $K\alpha_1$ line used in the measurements; but the result is the same for the line α_2, which according to M. Dauvillier is simple.—E. **Gleditsch** and B. **Samdahl**: The atomic weight of chlorine in an ancient mineral, Balme apatite.—J. **Durand**: The thermal treatment of some cast irons. Heating to 900° C. and slow cooling increased the proportion of graphite and diminished the resistance to breaking. Tempering in oil from 900° C. and repeating to 650° C. increased the breaking load.—M. **Charriou**: The separation of ferric oxide and alumina from lime by the nitrate method.—H. **Gault** and T. **Salomon**: The α-alkyl levulinic acids.—E. **Decarrière**: The *rôle* of gaseous impurities in the catalytic oxidation of ammonia. Extremely minute proportions of hydrogen phosphide (0·2 parts per million) poison the platinum catalyst in this oxidation, but the simultaneous presence of acetylene and hydrogen sulphide, especially the latter, partially neutralises the poisonous action of the phosphorus compound.—E. **Grandmougin**: The acyl and alkyl leucoindigos.—C. **Jacob**: Eruptive rocks of the intermediate series in North Annam and in Tonkin.—P. **Corbin**: Some sections on the eastern edge of the Vercors-massif.—L. **Guillaume**: Tertiary and existing Turritella: evolution and migrations.—P. **Lesage**: The determination of the germinative faculty other than by the actual germination of the seeds. A. Němec and F. Duchon have recently described a method based on the evolution of oxygen by the action of hydrogen peroxide on the diastase of the seed as the only method available for testing the vitality of the seed other than actual germination tests. The author directs attention to a method described by him in 1911 and 1917 based on the colour imparted to dilute solutions of potash by the seeds. This gives a definite result in four hours.—J. **Bouget** and A. D. **de Virville**: The influence of the meteorology of the year 1921 on the reddening and fall of leaves.—R. **Poisson**: Histogenesis of the flight muscles in Ranatra, Nepa (*N. cimicoides* and *N. maculatus*).—G. **Bourguignon**: Modification of the chronaxy of the skeleton muscles and their nerves by the repercussion of the lesion of the neurones with which they are functionally associated.—A. **Lumière** and H. **Couturier**: Traumatic shock.—C. **Levaditi** and S. **Nicolau**: The embryonic leaflets in relation with the affinities of the vaccine virus.—E. **Fernbach** and G. **Rullier**: The action of an artificial gastric juice on tubercular pulmonary granulations of the guinea-pig.

Academy of Sciences, March 20.—M. Emile Bertin in the chair.—A. **Haller** and Mme. **Ramart-Lucas**: New distinctive characters of the three propanol-α-camphocarbonolides melting at 141°, 117°-118°, and 89°-90° C. respectively.—G. **Mittag-Leffler**: Cauchy's theorem on the integral of a function between imaginary limits.—C. **Sauvageau** and G. **Denigès**: Remarks on the efflorescences of *Rhodymenia palmata*. The presence of a xylane in these algæ. The pentosane extracted by the method of Mme. Swartz from *R. palmata* gives xylose on hydrolysis and hence is a xylane. This is the first case of the extraction of this substance from an alga.—J. **Drach**: The determination of the differential equations of the second order integrable by quadrature.—G. **Julia**: The transformation of rational substitutions into linear substitutions.—M. **Stoïlow**: The definite integral and the measurement of *ensembles*.—J. **Ubach**: Observations of the partial eclipse of the sun of October 21, 1921, made at Buenos Ayres (Argentine Republic).—F. **Michaud**: A micromanometer with sensibility capable of regulation.—A. **Guillemet**: A new objective shutter for taking aerial photographs with apparatus with long focus.—V. **Henri**: The absorption spectrum of benzine vapour and the fundamental magnitudes of the benzine molecule. The absorption spectrum of benzine vapour has been measured at pressures between 0·01 and 65 mm. The ultra-violet spectrum can be represented very exactly by a formula derived from Bohr's theory, and consists of four series of superposed bands. The results show that the molecule of benzine is a very symmetrical structure, the movements of which obey the simple laws deduced for diatomic molecules.—F. W. **Klingstedt**: The ultra-violet absorption of phenol in different solvents. The absorption spectrum of phenol in solution depends on the nature of the solvent. Comparing with the spectrum of the vapour, one type of solvent (carbon tetrachloride and ether) produces only a displacement and enlargement of the bands. The second group of solvents (methyl and ethyl alcohol, and water) change the absorption spectrum completely. The spectrum of pure liquid and solid phenol is intermediate between the two preceding types.—C. **Chéveneau**: An optical method for the determination of the reciprocal solubility of slightly miscible liquids. The method is based on the use of a hollow prism divided into several compartments. The differences of the refractive indices of the two liquids are taken directly, independently of the temperature. The case of aniline and water is given and the results compared with the gravimetric method.—G. **Guilbert**: The observation of clouds and the prediction of weather.—H. **Joly**: The existence of phenomena of horizontal displacements of large amplitude at the eastern extremity of the Iberian chain, near Montalban (province of Téruel, Spain).—H. **Coupin**: Determination of the optimum of humidity of the external medium in the Oscillaria.—A. **de Puymaly**: The reproduction of Vaucheria by amœboid zoospores.—G. **Tanret**: The chemical composition of ergot of Diss (*Ampelodesmos tenax*) and the ergot of oats. Since the closing of the Russian frontiers ergot of rye has become extremely scarce, and the possibility of obtaining ergot from other Gramineæ is of immediate interest. Of the two plants mentioned, oats only would appear to contain sufficient of the active principle to be of practical service. From one kilogram of Algerian oats 1·8 gram of crude and 0·8 gram of pure crystallised ergotinine was isolated.—C. J. **Gravier**: The relations between the Crustacean and the sponge in the sponges carrying Cirripedes.

Official Publications Received.

Spolia Zeylanica. Edited by Dr. J. Pearson. Vol. 12, Part 45. Pp. 221. (Colombo: Colombo Museum.)

Department of Statistics, India. Agricultural Statistics of India, 1919–20. Vol. 1: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, Land Revenue Assessment, and Harvest Prices in British India. (Thirty-sixth issue.) Pp. ix+380+9 charts. (Calcutta: Government Printing Office.) 2.8 rupees.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Vincent, for the Year 1920. Pp. iv+32. (Barbados: Imperial Commissioner of Agriculture for the West Indies.) 6*d.*

Union of South Africa. Fisheries and Marine Biological Survey. Report No. 1 for the Year 1920. By Dr. J. D. F. Gilchrist. Pp. v+111+9 plates+4 charts. (Cape Town: Cape Times, Ltd.)

Report on the Progress and Condition of the United States National Museum for the Year ending June 30, 1921. Pp. 219. (Washington: Government Printing Office.)

State of Connecticut: Public Document No. 24. Forty-fourth Annual Report of the Connecticut Agricultural Experiment Station: Being the Annual Report for the Year ended October 31, 1920. Pp. xvi+377. (New Haven.)

Diary of Societies.

FRIDAY, April 21.

Institute of Transport (at Royal Society of Arts), at 5.—J. K. Bruce: The Operation of a Large Tramway Undertaking, with reference to Capacity and Cost under given Conditions.
Institution of Production Engineers (at Institution of Mechanical Engineers), at 7.30.—J. R. Smith: Electricity in a Machine Shop.
Junior Institution of Engineers, at 8.—S. A. Stigant: Condenser and Coke Coil Protective Apparatus.

MONDAY, April 24.

Royal College of Surgeons of England, at 5.—Prof. Shattock: Demonstration of Museum Specimens illustrating Repair.
Royal Institute of British Architects (at Olympia), at 6.—Prof. P. Abercrombie: What we mean by Town Planning.
Institution of Mechanical Engineers (Graduates' Meeting), at 7.—B. A. C. Hills: Jigs and Tools.
Royal Society of Medicine (Odontology Section), at 8.—J. H. Mummery: Dental Diseases in Ancient Egypt, demonstrating some Photographs forwarded by the late Sir Armand Ruffer.—E. Sprawson: (1) A Case of Multiple Follicular Odontomes (Dentigerous Cysts) in the Mandible, and some Remarks as to the Pathology of such Cysts. (2) The Significance of the Extra Cusp commonly found in the Antero-internal Aspect of the Maxillary First Permanent Molar in Man.

TUESDAY, April 25.

Royal Institution of Great Britain, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire. Series II. Racial Problems of Africa (1).
Royal Society of Medicine (Medicine Section) (at Middlesex Hospital), at 5.—Clinical Meeting.
Royal Statistical Society, at 5.15.
Zoological Society of London, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of March 1922.—R. J. Ortlepp: A New Species of the Nematode *Œsophagostomum* from the Rodent *Xerus setosus*.—Dr. C. F. Sonntag: The Anatomy of the Drill (*Mandrillus leucophæus*).—Dr. R. Broom: The Persistence of the Mesopterygoid in certain Reptilian Skulls.—A. Loveridge: New Reptiles from Tanganyika Territory.
Institution of Civil Engineers (Annual General Meeting), at 6.
Royal Photographic Society of Great Britain (Annual General Meeting), at 7; at 7.30.—Dr. T. S. Price: Gelatine.
Royal Anthropological Institute, at 8.15.
Royal Geographical Society (at Queen's Hall), at 8.30.—Lieut.-Col. C. K. Howard-Bury: The Mount Everest Country and People.

WEDNESDAY, April 26.

Royal Institution of Great Britain, at 3.—Prof. D. H. MacGregor: Industrial Relationships (1). The Historical Interpretation.
Royal Institute of British Architects (at Olympia), at 6.—Sir Lawrence Weaver: Modern Domestic Architecture; Fashion and Style.
Royal Society of Arts, at 8.—Dr. J. F. Crowley: The Uses and Advantages of Electric Power in the Factory, as illustrated by its Application to the Jute Industry.

THURSDAY, April 27.

Royal Institution of Great Britain, at 3.—Prof. E. H. Barton: Audition and Colour Vision (1). The Resonance Theory of Audition.
Child-Study Society (at Royal Sanitary Institute), at 6.—Dr. Octavia Lewin: The Natural Defences of the Upper Air Passages.
Institution of Electrical Engineers, at 6.—J. A. Kuyser: Protective Apparatus for Turbo-Alternators.
Concrete Institute (Annual General Meeting), at 7.30.—W. N. Twelvetrees: Reinforced Concrete Piers and Marine Works.
Optical Society (at Imperial College of Science and Technology, South Kensington, S.W.7), at 7.30.—Prof. A. Pollard: The Mechanical Construction of the Microscope, from a Historical Standpoint.
Oil and Colour Chemists' Association (at Food Reform Club, 2 Furnival Street, W.C.1).—F. H. Jennison: Studies of Precipitation.
Illuminating Engineering Society (at Royal Society of Arts), at 8.—Discussion on the Use of Light in Hospitals (including the illumination of hospital wards and operating-tables and some other applications of light).
Harveian Society (at Town Hall, Paddington), at 8.30.—Discussion, by Sir Humphry Rolleston and others, on Influenza.
Royal Society of Medicine (Urology Section), at 8.30.—J. Swan and others: Tests of Renal Function.

FRIDAY, April 28.

Zoological Society of London, at 4.—Anniversary Meeting.
Royal Society of Arts (Indian Section), at 4.30.—F. G. Royal Dawson: The Need of an All-India Gauge Policy.
Physical Society of London (at Imperial College of Science and Technology), at 5.—T. Smith: The Position of Best Focus in the Presence of Spherical Aberration.—F. Twyman and J. Perry: The Determination of the Absolute Stress-variation of Refractive Index.—C. J. Smith: An Experimental Comparison of the Viscous Properties of (*a*) Carbon Dioxide and Nitrous Oxide, and (*b*) Nitrogen and Carbon Monoxide.—F. Twyman: Demonstration of the Optical Sonometer.
Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of Museum Specimens illustrating the Forms of Inguinal Hernia.
Royal Society of Medicine (Study of Disease in Children Section), at 5.—Sir Robert Jones: Presidential Address.
Institution of Mechanical Engineers, at 6.—Prof. E. G. Coker and Dr. K. C. Chakko: An Account of some Experiments on the Action of Cutting Tools.
Royal Society of Medicine (Epidemiology Section), at 8.—Dr. F. Dittmar: Outbreaks of Enteric Fever associated with Carrier Cases.
Royal Institution of Great Britain, at 9.—Dr. A. Harden: Vitamin Problems.

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

WEDNESDAY, April 26.

University College, at 5.15.—Dr. D. H. Scott: The Early History of the Land Flora (1).

THURSDAY, April 27.

University College, at 5.15.—Sir Joseph J. Thomson: Atoms, Molecules, and Chemistry (1).—A. T. Walmisley: The Bridges over the River Thames at London.

FRIDAY, April 28.

Bedford College, at 5.15.—Prof. E. Claparède: L'Intelligence et la Volonté (1). (In French.)
King's College, at 5.50.—Dr. J. Hjort: Biological Aspects of Oceanography (1).

CONTENTS.

SATURDAY, APRIL 29, 1922.

Editorial and Publishing Offices:
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The Education Estimates.

THE Estimates for Civil Services for the year ending March 31, 1923, have been issued, and it is expected that Class IV., which deals with Education, Science, and Art, will be discussed in Parliament almost immediately after the Easter recess. While it is now clear that the drastic cuts recommended by the Geddes Committee will not be made, the Estimates in this class still show a reduction of 7,979,154*l.* for Great Britain—Ireland being omitted from this calculation. We propose to examine three items in which economies are indicated.

First, the estimate for the Ordinary Services of the Board of Education shows a reduction of 4,898,970*l.* on the corresponding estimate for the year 1921–22, which means a cut of rather more than 10 per cent. Next, the estimate of the grant in aid of Universities and Colleges for the year 1922–23 is 300,000*l.*[1] less than the sum granted to these institutions for the year 1921–22, which means a cut of 20 per cent. And, thirdly, the estimate for Scientific and Industrial Research is reduced by 118,486*l.*—a cut of 28 per cent.

It will be observed that the cuts for higher education and research are proportionately much greater than for the Ordinary Services of the Board of Education, and it would seem that this is the considered policy of the framers of the Estimates. A closer examination of the estimate for the Ordinary Services of the Board of Education seems to confirm this opinion. Here we find that the proposed reduction in the grants to local education authorities for elementary education amounts to 1,916,307*l.* on 36,900,000*l.*, which works out as a cut of about 5 per cent.; whereas the proposed reduction of grants to local education authorities for *higher* education amounts to 954,920*l.* on 6,647,920*l.*—a cut of more than 14 per cent.

If further confirmation were needed it is to be found in the treatment of technical colleges and the grant towards students' fees. The grant to the former is to be reduced from 50,000*l.* to 40,000*l.*—a cut of 20 per cent.; while the students' fees grant, from which scholarships, studentships, and exhibitions tenable at the universities are drawn, is to be reduced from 15,000*l.* to 12,600*l.*

Obviously these facts point to the conclusion that higher education and research are bearing a greater proportion of the proposed reductions in the Education Vote than the remaining educational services. Such a discrimination requires further consideration. At the outset we may say that we have no fault to find with the rejection of the Geddes proposals regarding the salaries of school teachers. In our opinion there was ample justification for refusing to adopt proposals of that character. Rather are we concerned to point out that the proposals regarding higher education and research, if carried into effect, will, in the long run, be most injurious to education and the development of our national life. In the debate on the Consolidated Fund Bill in the House of Commons on March 28, Mr. Asquith warned the Government of "the extreme and criminal inexpediency at this time of cutting down the Education Estimates." He then proceeded to ask "Was there ever a moment in our history when it would be more suicidal to cut down the facilities which were not by any means ample enough for this great national purpose of securing the best intellectual life for the boys and girls who were most fitted to profit by it?" Far from the facilities being ample enough, we understand that at the present time 20,000 children, well qualified for higher education, are excluded from secondary schools for lack of accommodation. Yet at this particular juncture the Education Estimates, as we have indicated above, show a reduction of more than 14 per cent. in the grants to local education authorities for higher education.

While the attack upon secondary education is bad, that upon the universities is worse. A cut of 20 per cent. will have far-reaching effects. Already one university is proposing to reduce its staff, and others are preparing to follow suit. This will mean impaired efficiency and the sacrifice of future developments. A temporary and trivial economic gain will cripple the universities for many years and inflict irremediable hardships upon many deserving students. We cannot understand

[1] The proportion of the decrease for Great Britain is estimated at 247,000*l.*

how a Minister of Education can agree to a reduction of 300,000*l.* to the universities when in the debate just referred to he stated that the universities "were making contributions to learning and science exceeding in quality and amount that ever given before," and further that "it was within his knowledge that there was work proceeding in the laboratories of this country which, if the hopes of scientific men engaged upon it were realised, would repay the country over and over again for the cost." Mr. Fisher must surely know that such a reduction in the grant cannot be made without serious consequences. The sum may be small in comparison with the Education Vote as a whole, but it is most certainly large in comparison with the funds at the disposal of the universities.

The President of the National Union of Teachers in his address to the Annual Conference on April 17 was at pains to point out that money spent on scientific and technical education was productive expenditure which would become the very source of national income. And he is right. He insisted that more money was required to enlarge our control over the resources of nature. "We shall want," he says, "more money to build and equip our technical schools and colleges. We shall want more money to train our scientists and technicians, for we could not float a world trade on scientific ignorance and technical inefficiency." Again he is right. Yet the Government is proposing to reduce its grants for such purposes!

Already thoughtful men and women are realising that the hope of the future in commercial life, as well as in intellectual life, lies largely with our universities and colleges, and that any action which will prejudice their development will mean a national loss. While we hold to the same opinion we are not prepared to say that the educational system of this country is run on sound economic lines or that the system itself from a purely educational point of view is beyond criticism. Any one with inside knowledge would have no lack of material for criticism. Our point is that the proposed economies in higher education and research are specious economies which in the near future will entail losses out of all proportion to the slight temporary gain they effect. On the other hand, we believe it would not be a difficult matter to discover ways of economising which would not entail such serious consequences as those proposed. We can only hope that Parliament will show a real appreciation of the inevitable consequences of the proposed drastic cuts, and that proper means will be taken to prevent so great a calamity to higher education and research.

Studies in Symbiosis.

Tier und Pflanze in intrazellularer Symbiose. By Prof. P. Buchner. Pp. xi+462+Tafel 2. (Berlin: Gebrüder Borntraeger, 1921.) 114 mk.

THE extent and significance of symbiosis are matters of general interest. The delicate adjustments that enable yeasts to interpenetrate the tissues of insects, algae those of corals, and bacteria those of cuttlefish, resulting in mutual advantages to both partners in each association, form an evolutionary topic of no little importance. But the subject assumes practical and economic value when it is realised that the nutrition of our domestic ruminant animals is carried out not solely by their own enzymes and tissues, but is due partially to the activity of symbiotic bacteria (and probably to Protozoa also) which live within the cattle. So great has been the increase of our knowledge of these associations in the last fifteen years, that the large volume under review does not cover the whole ground, but deals only with those animals in which the invading micro-organisms take up positions within certain cells of the other partner. The no less interesting cases of symbiosis in which the invader lies in the cavity of its partner's body (as in cattle) are, with one exception, deliberately omitted.

Accustomed as we are to think of each being as working out its own salvation and that of its race, the thought of deep-seated infection of diverse animals by myriads of alien microscopic yeasts or bacteria which invade even the very germ cells and are conveyed to children's children, has in it something repulsive. Such cases, we are inclined to conclude, are exceptional. The bulk of life stands on its own ground. Symbiosis is at best a secondary phenomenon of the struggle for subsistence. It is not even a safe compromise. Co-operation may mean litigation. Mutual benefit gives place only too easily to one-sided benefit or to mutual harm. The "symbiote" becomes a parasite. Requiring such a delicately adjusted balance, symbiosis, we argue, can never have been an evolutionary factor of real and widespread significance. In opposition to the entrance of such foreign corpuscles, the body would exert all its antigens as against foreign proteids or as it does against the entrance of pathogenic spores. The struggle would lead to the survival of those forms which repelled the invaders or which tolerated their presence whilst maintaining an easy mastery.

The facts of biology, however, imperfectly known as they are and still more imperfectly apprehended in their full significance, show that the more carefully animal life is studied, the more numerous and intimate are the cases of symbiosis that investigation discloses.

Many of the blood-sucking flies, probably all, are cases of symbiosis. The whole vast order of sucking insects known as Hemiptera—the green fly, scale insect, body louse—is another. The ant and the death-watch beetle, the cockroach and the leaf-miner are examples of other orders that show the same or similar associations.

The first section of Dr. Buchner's book deals with marine plant-animals, and provides a welcome and critical summary of our knowledge of the algal associations in Protozoa, Coelenterates and Turbellaria. The second, and perhaps the most valuable, part of the work gives a full, illustrated discussion of symbiosis in insects, with especial reference to the transmission of the bacteria or yeasts to the egg and the "infection" of the embryo. This aspect of insect physiology has been neglected by English entomologists, and its significance is as yet scarcely grasped. Some indication of the importance of insect symbiosis may be gathered from the fact that Peklo has shown the symbiotic organism of green-fly to be an Azotobacter modified by residence in the tissues of the insect. The only important omission in this part of the work is that of the recent discovery of a symbiotic organism in the tsetse-fly.

Native Life in the Highlands of Assam.

The Angami Nagas, with some Notes on Neighbouring Tribes. By J. H. Hutton. Pp. xv+480. (London: Macmillan and Co., Ltd., 1921.) 40*s*. net.

Mr. Hutton's excellent monograph on the Angamis is a more than welcome accession to the series of monographs dealing with the Naga and other indigenous tribes now under the control of the Government of Assam. The volume is a very valuable contribution to the ethnological literature of the Naga Hills, and reflects great credit both upon the author, who has made full use of his opportunities, and upon the Government under the auspices of which it has been published. Ethnologists, local administrators and many others will feel grateful to the authorities for their praiseworthy encouragement of the scientific study of the natives for whose welfare they are responsible. Such detailed study is not only of value from the ethnological point of view, but has also a practical bearing upon the administration of native affairs. Accurate knowledge of the habits, customs, beliefs and culture-environment in general of primitive peoples promotes sympathetic and equitable treatment and control, and prevents those misunderstandings and unintentional acts of injustice which are due to ignorance of the native point of view, ethics, and social organisation.

The present monograph, while it deals in detail with the various phases and features of the life of the Angamis, has the merit of being brightly written and interspersed with touches of humour. It is "readable" as well as instructive.

Mr. Hutton, during several years of close contact with Naga tribes, has developed a *sympathetic* interest in them which has gone far towards winning their confidence. Much of the information which he has gleaned could have been acquired only by breaking down those barriers of reserve and distrust which are too often interposed between the representatives of

Fig. 1.—Viswema youth in ceremonial dress. From "The Angami Nagas."

government and the governed. The facts which he records have been collected mostly at first hand, being the results of his own observations. Where he depends upon the data collected by his predecessors in the field, he has endeavoured to check off their statements and, so far as possible, to verify or correct them. Many of the practices recorded by Butler, Woodthorpe, Davis, Peal, and other pioneer observers are no longer followed, and must be accepted at second hand or studied through the imperfect memory of the "oldest inhabitant." The time-honoured practice of head-hunting is rapidly becoming extinct in the administered area, and the passing of this prominent and absorbing feature in Naga culture involves the atrophy of many other cultural items and the modifica-

tion or abolition of many status-grades in Naga society. Even those striking and elaborate ornaments (Figs. 1 and 2), which were formerly guarantees of prowess on the war-path, have, to a great extent, now lost their significance, and may be worn by those who have not earned them under the rules of the old *régime*. While recognising that changes are inevitable and, no doubt, even desirable, the ethnologist views with concern the supplanting of traditional customs by "civilisation," at any rate before they have been studied and recorded in detail. Similar regrets are felt by the naturalist when some interesting zoological type becomes extinct and is no longer available for research into its life-habits. Mr. Hutton's careful record has done much towards minimising the mourning over obsolescent customs. How rapid are the culture-metamorphoses which are being effected in the Naga Hills is well reflected by the author's statement that a considerable portion of his MS. was "typed by an Angami"! Truly, there is no time to lose, and it is to be hoped that he will continue his researches without interruption.

FIG. 2.—Mozema youth in ceremonial dress. From "The Angami Nagas."

There is much to be said in praise of the Angami, whom Mr. Hutton describes as intelligent, self-reliant, honest, good-humoured, and devoted to their families. While they may be declared swashbucklers and exaggerators, they are, nevertheless, fairly truthful. Underlying these characteristics there run a vein of sadness and a considerable fear of death. Their villages, built for defensive purposes on the high ground, testify to the inter-tribal feuds, vendettas, and head-hunting raids which have hitherto retarded progress and rendered the life of every man, woman, and child somewhat precarious.

The Angamis are prominent as agriculturists, and in this industry they are ahead of the neighbouring tribes, inasmuch as they practise, for rice-growing, a very elaborate and striking system of terrace-cultivation (Fig. 3) involving complex irrigation methods. Their irrigation channels extend sometimes for miles, and water-rights are jealously guarded. This terracing of the hill-sides reminds one of that of the Bontoc-Igorots of the Philippine Islands, and it contrasts with the crude and wasteful system of *jhuming* so prevalent among Naga agriculturists, including the Angamis themselves.

These natives are skilled in several manufacturing processes, in weaving, iron-working, etc., and exhibit great artistic feeling in decorating their weapons and houses and in making their often elaborate personal ornaments. But, in spite of skill and ability to progress, severe restrictions upon culture-advancement are imposed by the complex and inexorable system of magico-religious *gennas*, or prohibitions, which play a very important part in the Angami social ritual, and exercise a retarding effect upon the prosecution of industries. The various kinds of *gennas* and their application and social significance are dealt with very fully by the author. He explains the distinction between *kenna*, which is a prohibition laid upon an individual unit of the community, and *penna*, one which involves the whole community and relates chiefly to non-working days; the latter are very numerous. Further, there is *nanü*—which embraces *any* prohibition and the whole of the active ceremonies connected with it. It is impossible in a review to deal with these social restrictions, but their dominating influence upon the whole life of the natives is very far-reaching, and their detailed study of prime importance.

The religious beliefs are vague and ill defined. There is belief in the souls of the dead and, it would seem, of the living also, and these often take the form of butterflies, as in Burma and in the Greek legend of Psyche. The reality of dreams and their value in divination are also recognised. Omens and divination to a considerable extent regulate procedure. Certain major and minor deities or spirits (*terhoma*) of greater and lesser power exist and are propitiated, and sometimes even defied, but their exact nature is but little understood. The chief of these is Kepenopfü, variously referred to as male or

female, who is the reputed creator of living things and whose abode is in the sky. Animatism prevails, and were-tigers and were-leopards are a feature in the popular beliefs. With all these matters Mr. Hutton deals interestingly and in some detail, though he wisely assumes a cautious attitude in describing the native beliefs in view of the uncertainty of the material.

Fig. 3.—Viswema village showing terraced fields. From "The Angami Nagas."

The arts, industries, amusements, and general domestic life, the laws and customs and other culture-phenomena all receive adequate attention, and a number of traditions, legends, and songs are recounted. An important chapter deals with the Angami language, which belongs to the Tibeto-Burman group. There are also several valuable appendices concerned with special points, including a series of anthropometric measurements. It is to be hoped that the Stone Age of the Naga Hills may be the object of further researches. Our knowledge of it is mainly, almost exclusively, derived from stone celts which are locally believed to be thunderbolts, and are valued as such by the natives. One assumes that other types of stone implements, which may be revealed by careful search, must have been associated with the celts. They should throw light upon the archæology of the region, a subject which as yet remains obscure.

A few words of criticism are called for. Some of Mr. Hutton's descriptions are by no means clear. For instance, on p. 68 mention is made of a "trumpet" upon which military bugle-calls are reproduced, but which is not "blown with a loose lip." If this is so, the instrument should not be described as a "trumpet," and one wonders how bugle-calls can be imitated without the "loose-lip" method of sound-production. Again, on p. 93, we learn that "millet and Job's tears . . . are . . . used for making rice beer," but these ingredients are not referred to in the description of the brewing of this staple drink, and one remains uninformed as to their function in the process. On p. 94 the reasons given for the food-*genna* to women are far from clear, and require further elucidation to show the connection of ideas. In a future edition of this excellent book it will be well if all native words and place-names are accented throughout, so as to assist the uninitiated in their correct pronunciation. This should be a general rule in all works of this nature. The illustrations are mostly good, several are very good, and they are well placed in reference to the text, but references to particular figures should appear in the letterpress. Three useful maps are added.

Mr. Hutton's enthusiasm and industry in recording the details of native life in the Naga Hills are evidenced not only in his book upon the Angamis, but also in his more recently published work on the Sema Nagas. These books are so full of information in regard to this important ethnological region that one thirsts for more, and can only hope that other Naga tribes (the Aos, Rengmas, Konyaks, etc.) may be described in a similar manner. "The Angami Nagas" may well serve as a model for further monographs. We congratulate Mr. Hutton and his readers upon a valuable and enlightening piece of work.

Henry Balfour.

The Manufacture of Explosives.

Ministry of Munitions and Department of Scientific and Industrial Research: Technical Records of Explosives Supply, 1915–1918. No. 1: *Recovery of Sulphuric and Nitric Acids from Acids used in the Manufacture of Explosives: Denitration and Absorption.* Pp. viii+56. 12s. 6d. net. No. 2: *Manufacture of Trinitrotoluene* (TNT) *and its Intermediate Products.* Pp. viii+116. 17s. 6d. net. No. 3: *Sulphuric Acid Concentration.* Pp. vi+91. 12s. net. No. 4: *The Theory and Practice of Acid Mixing.* Pp. vi+93. 12s. net. (London: H.M. Stationery Office, 1920–1921.)

The first four of the series of publications dealing with the technical records of explosives supply now to hand form a valuable addition to the literature of technical chemistry. The work of preparing the

information was begun by Mr. W. Macnab under the Ministry of Munitions, and thanks are due to the Department of Scientific and Industrial Research for arranging for his retention to complete it.

Denitration.—The first volume deals with the recovery of the nitric and sulphuric acids from the waste acid produced in the nitration of toluene and glycerine. Not only is the proportion of waste acid a large one—650 tons for 100 tons of trinitrotoluene produced—but the efficient recovery of the sulphuric acid in a condition suitable for concentration, and of the nitrogen oxy-acids as nitric acid, constitutes one of the principal economic factors of the manufacture.

The chemical reactions involved in denitration have been the subject of discussion both earlier and as a result of experience in war factories, and the position is summed up in the introduction to this volume. It may briefly be said that by considering the behaviour of nitrosylsulphuric acid when it acts on nitric acid, and when it breaks down on dilution with water, a fairly coherent explanation is afforded of what goes on during the progress of waste acids down a denitrating tower as they meet an ascending current of steam.

The treatment of the subject of the absorption of the nitrous fumes coming from the towers to form 55 per cent. nitric acid is of importance at the present time, when this problem confronts any manufacturer proposing to make nitric acid by the catalytic oxidation of ammonia. The experience recorded is that a 90 per cent. conversion of nitrogen peroxide to nitric acid can be secured with a ratio of free tower space to rate of passage of nitrogen peroxide, which is less than a tenth of that in large towers erected for the same purpose in connection with the oxidation of ammonia. The relative effectiveness of the small towers with the most advantageous conditions of concentration and velocity of gases and free space, temperature, and concentration of nitric acid, is clearly indicated, and forms a basis for modification of the present practice of installing immense absorption towers which are obviously inefficient and very costly.

Full detailed drawings are given of the plant for the processes of denitration, absorption, and storage of acids, and its applicability to the manufacture of organic nitro-bodies should make the report of interest and importance to a wider field than that of the explosive manufacturer alone.

Trinitrotoluene Manufacture.—No. 2 of this series gives the history of processes for making trinitrotoluene and for its purification, and describes plant and manufacturing methods. An account is given of the experimental work at the Research Department, Woolwich, which established the conditions necessary for nitration, the advantage of the extraction of waste acids ("detoluation") by mononitrotoluene, itself to be nitrated later, and the benefits of a cyclic system of nitration in stages in order to conserve acids. These features were embodied in the processes followed in the large factories erected for making trinitrotoluene, an important variation, however, being the elaboration at Oldbury of the counter-current method into a continuous process, which had a high capacity combined with low labour and capital cost.

In the process as carried out at the largest factory, Queen's Ferry, mononitrotoluene, made separately either by nitrating gas-works toluene or the toluene contained in Borneo petroleum, was used to detoluate waste acids which had themselves been detoluated by once-used mononitrotoluene, brought up to nearly dinitrotoluene in the last-mentioned operation, and this dinitrotoluene was then nitrated to trinitrotoluene.

The next process, that of freeing the crude trinitrotoluene from acids, underwent some elaboration, for in addition to agitation of the molten trinitrotoluene by hot water it was found efficacious to chill it by pelleting it in cold water, and to use weakly basic hydrolysable salts for the hot washing ;. a continuous system of hot washing was also developed.

But although it became possible latterly to push the process of nitration until nearly all the dinitrotoluene had been converted into trinitrotoluene, there remained about 4 per cent. of its unsymmetrical isomerides resulting from the nitration of the metanitrotoluene. While the crude trinitrotoluene, after having been washed and dried, could be used in large quantities for making the bulk of the amatol for filling shell, there were certain purposes for which a purer product was demanded, when, for example, the ammonium nitrate was not free from pyridine and thiocyanate, or when it was necessary to avoid the low melting-point eutectics formed by the isomerides. Purified trinitrotoluene was prepared at first by crystallisation from, or by washing with, organic solvents, and large factories were erected for these purposes. Later, a process was adapted from the French, safer from the point of view of fire-risk, and characterised by treating the crude trinitrotoluene with sodium sulphite solution which under suitable conditions selectively dissolves out the other isomerides, leaving the pure symmetrical trinitrotoluene and any dinitrotoluene that has escaped further nitration. As this process was one which could readily be embodied in the scheme of manufacture, it was carried out in the trinitrotoluene factory.

The plant at Queen's Ferry, which in every detail is stamped with the genius of Mr. K. B. Quinan, is described in this volume in all relevant particulars as to the main features of the manufacture. The reproductions of the working drawings, the diagrams

and flow-sheets, the detailed sketches of parts and of special devices, and the examples of methods of statistical control, constitute a body of information of a unique character. The description forms a permanent record of these matters in a connected narrative, but again its usefulness is by no means confined to the explosives manufacturer, since many of the methods used and devices for overcoming difficulties are subject-matter for numerous projects in chemical engineering.

Concentration of Sulphuric Acid.—In the third volume will be found a useful study of the thermal conditions obtaining in the Gaillard tower system. The methods used before the war in this country for concentrating the sulphuric acid of 70 per cent. strength resulting from processes of nitration were for the most part the Kessler and the cascade systems, both of which are operated with comparatively small units. Excellent results both as regards efficiency and low cost of working were obtained with the large Gaillard towers erected in the large explosives factories such as Queen's Ferry and Gretna. The feature of these towers is the conversion of the weak acid into a spray, which in falling by gravity down a tower of about 50 ft. in height, meets ascending hot gases from a producer, and so becomes concentrated to a strength of 92-95 per cent. sulphuric acid. As the fuel consumption, weight of dilute acid, and weight of concentrated acid can be measured with fair accuracy, the opportunity is taken to calculate the efficiency of the plant from a knowledge of the various thermal data available, including those of Porter for sulphuric acid and oleum. The various factors are considered in detail which will repay the study of technical students, and a satisfactory heat balance is made out in which the heat imported into the system is contrasted with that which is lost by water evaporating, by radiation, and by being carried away in the hot acids. As the last-mentioned source of loss amounts to nearly a quarter of the heat put into the system, its recovery on counter-current lines by suitable constructional modifications would appear to be worth attempting.

A short study follows of the Gilchrist concentrating plant, which worked on a process analogous to that of the Kessler plant, but with a high capacity.

It had been a disadvantage in all the varieties of concentrating plant mentioned that the gases finally discharged into the air carried with them a mist of dilute sulphuric acid in water, involving a certain loss of acid and considerable inconvenience to those working in the neighbourhood. It was also objectionable in explosives factories where many large-scale operations have to be conducted in an acid-free atmosphere. Accordingly it was determined to precipitate this mist electrically by the Cottrell electrostatic process, of which full details are given and also a description of all the electrical parts and their mode of maintenance. As about 3 per cent. of the acid fed into the concentrating plant was recovered in the Cottrell precipitating plant, it will be seen that besides the advantages mentioned, a useful addition to the yield of acid was obtained.

Acid Mixing.—In No. 4 of this series is described the working of that important section of a nitration factory in which the acids are adjusted as regards their quantity and composition. In such a factory as Queen's Ferry, where 700 tons of trinitrotoluene a week could be made, the magnitude of the problems of production, handling, and conveyance of acids may be judged from the vast quantities—about 43,000 gallons—of nitric and sulphuric acids occurring in many stages of dilution. It is essential to secure that the various acids are in balance for controlling the cycle of production and recovery in manufacture. An example for a given output of explosive is worked out, and a diagrammatic acid balance figured, which includes a set of factors by which the quantities of acid at various stages must be modified to compensate for variations in working of the units composing the acids cycle. In this way the proper quantity of mixed nitrating acids of a definite composition and the economical utilisation of spent acids are kept under strict control.

As variations in dilution and in strength of the concentrated sulphuric and nitric acid inevitably creep in, calculations must be made of the adjustments necessary to bring the contents of the large mixing vessels to the desired composition. The methods for doing this are explained, and it is of interest to note that the presentment of the necessary data in the form of graphs was abandoned in favour of a series of simple tables by means of which the necessary additions for obtaining a correct mixing could be found.

A description is given in detail of the plant for storing and mixing these acids, and this completes the account of the manufacture of trinitrotoluene contained in vol. 2.

Apart from its value as an exposition of scientific method applied to the control of acid mixing for a nitration process on the largest scale, there will be found other subject-matter, such as descriptions of the mechanical details, methods of controlling undue rise of temperature, prevention of wear of parts, and methods of distribution of acids by pipes, which will be found to have a wide interest among those concerned with the erection of plant.

It is clear that the publication of the data which

have accrued in the operation of these factories will form a permanent record of the application of scientific method to problems of chemical industry, as well as affording typical examples for the use of students as well as of manufacturers. It is to be regretted that Queen's Ferry factory, which embodies so much original work in plant construction, is now for disposal, but it is understood that while there is yet time the Disposals Board have acquiesced in an arrangement for students to study the plant. A course of this kind with Mr. Macnab's volumes as text-books should prove a very valuable means of instruction.

Popular Expositions of Relativity.

Relativity and the Universe: A Popular Introduction into Einstein's Theory of Space and Time. By Dr. Harry Schmidt. Authorised Translation by Dr. Karl Wichmann. Pp. xiii + 136. (London: Methuen and Co., Ltd., 1921.) 5*s.* net.

The Ideas of Einstein's Theory: A Theory of Relativity in Simple Language. By Prof. J. H. Thirring. Translated by R. A. B. Russell. Pp. xv + 167. (London: Methuen and Co., Ltd., 1921.) 5*s.* net.

An Introduction to the Theory of Relativity. By L. Bolton. Pp. xi + 177. (London: Methuen and Co., Ltd., 1921.) 5*s.* net.

Relativity and Gravitation. Edited by J. Malcolm Bird. Pp. xiv + 245. (London: Methuen and Co., Ltd., 1921.) 8*s.* 6*d.* net.

The Rudiments of Relativity: Lectures delivered under the Auspices of the University College, Johannesburg, Scientific Society. By Prof. J. P. Dalton. Pp. vi + 105. (London: Wheldon and Wesley, Ltd., 1921.) 5*s.* net.

Die Einsteinsche Gravitationstheorie: Versuch einer allgemein verstandlichen Darstellung der Theorie. Von Prof. G. Mie. Pp. iv + 67. (Leipzig: S. Hirzel, 1921.) 7 mk.

HERE are six accounts of the Relativity theory designed for the general reader. The first four hail from Messrs. Methuen, who had the enterprise to secure an English translation of Einstein's own popular exposition, and have also recently published a translation of Weyl's "Space, Time and Matter." The fifth is published in Johannesburg by the Council of Education, Witwatersrand. The last comes from the pen of an eminent German professor of physics.

In surveying such a collection it is appropriate to quote from the last named. "We cannot penetrate into the thought-world of a symphony by reading a description of it, be it by the most distinguished musical critic. The symphony must be heard. The more we analyse it note by note, and the more deeply we understand the relations of the notes, the more do we come into the real meaning of the work."

That is the feeling which emerges after going one after another through many attempts to describe this new theory without asking the reader that he should first equip himself for the act of appreciation by an intimate study of the technique and terminology of geometry, of the significance of Newton's theory of gravitation and his system of mechanics both as an explanation of known phenomena and as forming the whole basis of the further development of physical science. But even granting these prime requisites, the reader is desired, on the strength of the reading of a few simple pages, to readjust the whole of his outlook on the world to an degree even greater than that required for one brought up in a classical school of art to comprehend the strivings of the moderns to find a new mode of expression for the thoughts of a new age.

This much is certain, that there is no short-cut to an understanding of Einstein's achievement. What is the most that we can expect from these many attempts to supply the public with some answer to their inquiries for light on this latest achievement of the imagination and intellect in co-operation? We may legitimately ask for some presentation of the historical setting. But even here we are faced with a great difficulty in providing an account which is free on the one hand from technical difficulties and on the other from misleading vagueness. For the precise statement of the actual achievements of Newton is in itself a matter requiring so much detail that the majority of our university students would not show up well in an examination on this subject. They are content with a parrot-like learning of the conventional language in which the laws of motion are expressed, and a false facility in doing problems without any reference to their physical significance. Meanwhile the Newtonian conceptions of space and time are absorbed as if they were strictly obvious, whereas the mere fact of the existence of Newton's definitions of absolute space and time shows that after all his investigations he found himself bound to postulate something which his reason and conscience could not justify. Newton's absolute space, like Euclid's axiom of parallels, were last confessions of remaining mysteries rather than preliminary statements of the obvious.

Yet it is not possible to appreciate the bearing of the relativity theory without appreciating first the point at which the classical mechanics is unsatisfactory. For it is perhaps the greatest merit of Einstein's work that it gives us something which is more satisfactory

just at this point. Einstein has met the greatest of all objections both to Newtonian mechanics and to Euclidean geometry. He has satisfied the logicians, and it so appears that, beginning with this sole end in view, he has found the explanation of the outstanding discrepancy with observation.

After the historic setting the most important element in an exposition of this theory is an analysis of the nature of measurement and of exact observation. The new element in the general theory of relativity is directly concerned with this. Einstein insists on the fact that the use of co-ordinates to distinguish between events is a piece of mathematical machinery; that the physical facts are there, and are the same, whatever descriptive method we may employ. On the other hand, measurement is simply a particular part of physical observation. On this point much more exact thinking is needed. The expositions of relativity, on the other hand, almost without exception encourage more than usually loose thinking. The strictest logical analysis cannot be avoided.

But after all the test of a popular exposition is whether it is really illuminating to the amateur reader. The reviewer is not entitled to pass hasty judgment. Nor is he entitled to compare these books on the score of their strict accuracy in detail. For the success of the author's attempt is relative to the previous knowledge and habit of thought of the reader.

One or two words of reference to the par icular features of these publications may, however, be made. Dr. Schmidt's account is colloquial and entertaining, and shows that the author feels the story of physical science to be part of the wonder book of the universe. Dr. Thirring is more severe and academic; but at the same time is lucid and free from exaggerations and misleading illustrations. Mr. Bolton's essay is interesting as the expansion of the 3000-word essay which won the prize offered by the *Scientific American*. Mr. Bolton remarks in his preface that the general drift of the theory was a greater obstacle to an understanding of the subject than the details of the advanced mathematical work, and he has written the book with a lively recollection of his own troubles. The fourth of Messrs. Methuen's publications is the most interesting. It is a collection of the best portions of the essays sent in for the *Scientific American* prize. This book will give hours of interesting reading from a multitude of points of view.

Dr. Dalton's Lectures in Johannesburg have been reproduced attractively and are very readable, while Prof. Gustav Mie gives us the point of view of one who has himself contributed a good deal to the discussion of fundamental physical theories.

The Induction Motor.

The Induction Motor and other Alternating Current Motors. By B. A. Behrend. Second edition, revised and enlarged. Pp. xxiii+272. (New York and London: McGraw-Hill Book Company, Inc., 1921.) 24*s*. net.

A FULL discussion is given in this book of the practical theory of the induction motor and of several of the main types of alternating current motors. The author also gives a historical account of the invention of the induction motor and of the development of its theory. He attributes the invention to Nikola Tesla in 1888. In England it is generally attributed to Ferraris, who certainly made an induction motor, the rotating part of which was a solid copper cylinder, in the autumn of 1885. In this connection also, Baily has some claim to be called the inventor, as he showed a disc revolving in a rotating magnetic field to the Physical Society of London in June 1879. Tesla and the Westinghouse Co., however, were the first to make a motor similar to those used to-day. They had great difficulties to contend with, as the standard frequency of alternating current supply in America in 1888 was 135.

In 1895 the author first developed his theory of the induction motor. He showed that in an ideal motor the locus of the extremity of a vector representing a phase current is a circle, and that from this circle the engineer can foretell the working of the machine. This circle diagram has proved of the greatest value to the designer and is in world-wide use, although it is known that in consequence of certain assumptions made in the course of the proof it is only an approximation. An immense amount of ingenuity has been expended in trying to make it more accurate, but we are very doubtful of the value of these corrected diagrams. Very often the authors unwittingly introduce new assumptions—for instance, that all the vectors lie in one plane—which may introduce appreciable errors into their results.

There are two parts in an induction motor, the stator or fixed part containing the windings carrying the polyphase currents which produce the rotating magnetic field, and the rotor, which is rotated by this field and from which mechanical power is taken from a pulley on its shaft. The induced alternating currents in the rotor are quite distinct, and have a different frequency from the alternating currents in the stator. The mutual inductance coefficients between the stator and rotor windings are not constants, and the inductances of the windings are only approximately constant. The problem is therefore difficult, and great credit is due to the author for discovering that the speed,

torque and efficiency at all loads can be found very simply by constructing a certain circle and drawing various lines.

Theory shows that the torque developed when switching one of these motors into circuit is greatly increased by increasing the resistance of the rotating circuits. Many inventions have been devised, so that the resistance of the rotor circuits automatically diminishes as the speed increases, thus securing high initial torque with economic working. It is interesting to learn that in the rotors of the two-phase motors used in the U.S. battleship *New Mexico* there are two windings. The outer is made of a high-resistance alloy and the inner has low resistance. The outer winding produces the initial torque, but the inner produces the greater torque at normal speed.

The author defines the leakage factor of a motor as $L_1L_2/M^2 - 1$, where L_1, L_2 are the inductances of a stator and rotor winding respectively and M is the mutual inductance between them. We much prefer Behn-Eschenburg's definition, namely, $1 - M^2/L_1L_2$. The latter is always a fraction lying in value between 0 and 1. The former varies between 0 and infinity. We also think it better to talk about motors being "in cascade" rather than "in concatenation." We regard this book as an important contribution to the practical theory of alternating current machinery.

A. Russell.

Our Bookshelf.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. xxiii.: *Lead and Zinc Ores in the Pre-Carboniferous Rocks of West Shropshire and North Wales.* Part 1, West Shropshire. By B. Smith. Part 2, North Wales. By H. Dewey and B. Smith. Pp. iv+95. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1922.) 3s. net.

Reports on the lead and zinc ores of Scotland, of Cornwall, Devon and Somerset, of the Lake District, and of the carboniferous rocks of North Wales have already appeared, and the three remaining volumes of the series, dealing with British lead and zinc ores in the remainder of the country, are promised shortly. It is of the utmost importance in the interests of economic geology that this work should be done now, before it is too late; but unfortunately it is becoming only too clear that the interest is a purely academic one, and that the industry of lead and zinc mining in Britain is in a moribund condition. It is obviously impossible that our relatively small deposits, some of which have probably been worked for 2000 years, can compete in the world's markets against the vast masses of mineral, the development of which is of quite recent date, which are to be found in the United States, Australasia, Burma, etc., and it must be regretfully admitted that it is impossible to bolster up an industry that has to contend with such crushing disadvantages, both natural and artificial. For reasons that are well known to all students of mineral deposits, our veins of lead ore were richer and more easily worked at the outcrops than they are to-day; we are far indeed from the days of Pliny, according to whom lead was found in Britain near the surface of the ground in such abundance that it was found necessary to limit strictly the output.

The volume before us describes the occurrences of lead and zinc in two districts, which have probably been thus grouped together on account of their marked geological similarity, the ores in both occupying fault fissures in the older rocks of Cambrian, Ordovician and Silurian age. The individual mines are described accurately and minutely, and the description is in many cases supplemented by sections taken from the actual mine plans. It is only to be regretted that more attention has not been paid to the introductory chapters dealing with the districts as a whole, particularly as regards the statistical portion. No summary of district statistics is given for North Wales, and that for Shropshire is indicated only by means of a small graph, which shows the general features of its rise and fall, but from which it is impossible to obtain exact figures.

H. L.

Elementary Chemical Microscopy. By Prof. E. M. Chamot. Second edition, partly rewritten and enlarged. Pp. xvi+479. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 25s. net.

The first edition of this work was reviewed at some length in Nature in 1915 (vol. 96, p. 84) shortly after its appearance. The subject of chemical microscopy, however, received a great impetus during the war, many new applications revealing themselves in the special war industries, which resulted in a more extensive use of the microscope in applied chemistry than at any time during the last quarter of a century. Hence, a new edition of this book was found necessary in America, and it is somewhat disappointing to find that practically no new methods or processes, and but little new apparatus, are described. The lack of photomicrographs of typical microscope fields of characteristic crystals produced in the tests described is still very obvious, but the author on the one hand promises a second book to make good this deficiency, and on the other states that this present book is primarily intended as a text-book (especially for the students of Cornell University), and not as a book of reference, and that the method of instruction in the Cornell course is intentionally one which leads to the best results when the student is encouraged to discover for himself (under guidance) the characteristic morphology of the materials studied.

The same more or less antiquated crystallography is retained, in which such terms as "optical elasticity," "hemihedral," and "tetartohedral" constantly occur, and the confusion between trigonal and hexagonal crystals is so complete that the former term is not even mentioned.

This second edition is, however, an improvement, for several obscure portions of the first edition have been

rewritten, and some of the inadequate practical details have been amplified. The chapter on the ultramicroscope stands out, as before, as one of the best in the book, and the later apparatus of Zsigmondy is here described. Moreover, the book is clearly printed in good-sized type, and the illustrations, although only the reproductions of line drawings, are unusually good for this class of figure. A. E. H. T.

(1) *Photo-Engraving Primer: Concise Instructions for Apprentice Engravers or for those seeking simple yet practical knowledge of Line and Half-Tone Engraving.* By S. H. Horgan. Pp. xvi+100. (London: P. Lund, Humphries and Co., Ltd., 1921.) 5*s.* net.

(2) *Byepaths of Colour Photography.* By O. Reg. Edited and with an Introduction by William Gamble. Pp. xii+116+xiii-xx. (London: P. Lund, Humphries and Co., Ltd., 1921.) 5*s.* net.

Both these volumes are by "practical men," and they are characterised to the full, if we may say so, by the advantages and the disadvantages that might be expected to result from this fact. Each has a critical and, to a certain extent, supplementary introduction by Mr. W. Gamble, so that the reader may feel fully assured that he is in safe hands. (1) Mr. Horgan goes clearly and concisely over the subject as he has practised it, and as he is a man of great and prolonged experience, his instructions cannot fail to be of value to the student, whether or not he has arrived at the stage of workman. But it is not a treatise on the subject. The author leaves theory quite on one side, though here and there he justifies his directions by a shrewd statement of the trouble likely to follow variations of them. Perhaps the chief matter to notice is that Mr. Horgan uses collodion, while in this country gelatine plates have largely replaced it.

(2) Mr. Reg clearly describes his own system in which he uses a one-exposure camera, with one reflector and one compensator, and plates specially sensitised. He gives full details as to the making of the camera, formulæ for sensitising the plates, and instructions for the general procedure. Rather more than half the volume is devoted to throwing what he calls "sidelights" on certain notions of previous inventors. Here he is not always lucid, and his excursions into theory are not always fortunate. But he has been a diligent searcher with regard to the methods of other workers in this field, and gives many useful dates and references to patents, with illustrations of apparatus. He calls his volume "byepaths," and in this sense it is both useful and interesting. C. J.

Forestry for Woodmen. By C. O. Hanson. Second edition. Pp. 238+13 plates. (Oxford: At the Clarendon Press, 1921.) 6*s.* 6*d.* net.

During the ten years that have elapsed since the first edition of this book was published, much progress in the art of forestry has been made in this country. The necessity of having within our shores an ample store of growing timber to meet the possible emergency of war, is now admitted by statesmen. The Forestry Commission established in 1919 has been busily engaged in acquiring land for new plantations and in re-afforesting the extensive areas which were denuded of timber during the war. Municipalities are awakening to the useful work of covering their water-catchment areas with trees, as evidenced by the new scheme of the Glasgow Corporation, which, if carried out, will create around Loch Katrine a magnificent forest, such as that owned by Liverpool at Vyrnwy in Wales.

The interest in forestry is increasing, and there is a demand for elementary instruction on the subject. This has been met by the publication of the second edition of this useful manual. It is well adapted for the purpose, being cheap in price, handy in form, and simple in language. Scarcely any change has been made in the original text, but two chapters have been added. One deals with the Forestry Act of 1919 and the Forestry Commission, and gives a summary of recent developments. The other new chapter treats briefly the afforestation of waste land, and gives a sketch of the survey necessary before any planting scheme can be decided upon. The book is brought up to date by the intercalation of a new paragraph here and there, and it may be recommended to landowners, as well as to agricultural students and forestry apprentices, as a satisfactory guide to elementary forestry. The index is, however, incomplete, and should be enlarged to double its present size in a new edition.

Problemi di Filosofia Botanica. By Antonino Borzi. Pp. 344. (Roma: G. Bardi, 1920.) 60 lire.

The introduction of this posthumous work contains a short historical sketch of vegetable biology, as foreshadowed by the elder Agardh, Delpino (to whose memory the book is dedicated), Haeckel, and others. The scope of the book itself is best indicated by the chapter headings: I. General conceptions and limits of vegetable ecology; II. Ecological principle of vegetable organisation; III. Ecological principles of vegetable associations; IV. Ecology of dissemination; V. Aerophylactic function in the vegetable kingdom; VI. Hydrophylactic function in the vegetable kingdom; VII. Form and evolution of the earliest vegetable life. VIII. Ecological conception of the evolution of the vegetable kingdom.

The author, a specialist on Cyanophyceæ, sums up very ably in chap. vii. his observations on the evolution of that group, and describes their extraordinary adaptability to varying ecological conditions. Continuous vegetative reproduction means a progressive development, from which no return to an earlier stage ever occurs; but development of the sexual function arrests such indefinite evolution and lays the foundation of constant characters. "Mutation" occurs before the development of sex. The polyphyletic origin exemplified in Cyanophyceæ is also manifested in the scheme of the entire vegetable kingdom.

The view generally held, that subaqueous life represents the primitive condition of terrestrial vegetation is regarded as unproved. Hydrophytes and aerophytes are probably two distinct stocks, the former representing primitive vegetation, the latter originating as Vascular Cryptogams at the period of land-emergence. That Bryophytes may possibly be survivals of a transitional stage between Hydrophytes and Aerophytes is not sufficiently clear. These views are set forth in detail.

40 Blätter der Karte des Deutschen Reiches 1 : 100,000 *ausgewählt für Unterrichtszwecke.* Erläuterungen bearbeitet von Dr. W. Behrmann. Veröffenlicht von der Gesellschaft für Erdkunde zu Berlin. Zweite Auflage. Size 17 in. × 15 in. Handbook, Pp. 62. (Berlin: R. Eisenschmidt, 1921.) Germany, 60 marks; England, 180 marks.

The portfolio of forty maps under notice consists of reprints of German surveys on the scale of 1 to 100,000. The first edition, published some nine years ago, was essentially the same except for three sheets, Metz, Gebweiler, and Oltingen, which have been omitted since the regions they cover are now outside German territory. Three other sheets have been substituted. The collection has been made for educational purposes, and with this end in view illustrates as many types of land forms and geographical features as possible within the limits of the country. The sheets, which are in black and white, are finely printed and leave no ground for criticism as regards reproduction. Surface features of relief are shown by hachures only. This method, excellent as it may be for a general impression, gives no absolute information and precision of detail. It has also the disadvantage of making the map so dark on the steeper slopes that other symbols, and particularly the names, are almost illegible. In fact, if these sheets have any great fault, it is one common to most German maps, namely, the attempt to show more than the scale will allow. In spite of this, however, the collection should prove extremely useful, and might well be imitated for the British Isles by the Ordnance Survey. A pamphlet giving a description of the sheets accompanies the portfolio.

Physical Map of England and Wales, 1 : 1,000,000. Size 34½ in. × 26 in. (Southampton: Ordnance Survey Office, 1922.) 2*s.* (Not less than 20 copies for educational purposes, 1*s.* each.)

The Ordnance Survey has produced a beautifully printed map which leaves little to be desired in the way of cartographical skill and excellence in reproduction. Surface relief is shown by layer colouring in green and brown. The contours are at 200, 400, 800, 1200, and 2000 feet. Rivers, lakes, and water names are in blue; other names are in black. No submarine relief is shown. The addition of this would improve the map for educational purposes. Some criticism may be offered with regard to the names. These are comparatively few in number; this is certainly an advantage, but a few more names of physical features might have been inserted. The fine black type used for these names does not obscure the map, and we miss such names as Charnwood Forest, Solway Plain, Fenland, Forest Ridges, or Aire Gap. The system on which the town names, printed in heavy black, have been selected is not very apparent. Such towns as Oldham, Sunderland, Gainsboro', Yarmouth, and Goole, to mention only a few large places, are omitted while many relatively unimportant names are to be found. The nearest towns to Manchester to be found on the map are Buxton, Liverpool, and Northwich, while in other less populated parts of the country the names are more crowded. No administrative names and no communications are marked. The low price is noteworthy.

Contribution à l'Étude de la Flore du Katangar. Par E. de Wildeman (Comité Spécial du Katanga). Pp. viii + cxliv + 264. (Bruxelles: D. Reynaert, 1921.) n.p.

The large district of Katanga forms the south-eastern corner of that part of Africa which is now under Belgian rule. It is governed by the Comité Special du Katanga, under the auspices of which this account of the vegetation of the country has been prepared and published. Four districts are recognised in considering the flora, namely, the Kasai, the middle Katanga or Upper Congo, the district of the great lakes, or the Tanganyika region, which forms the eastern limit, and the Upper Katanga district. A sketch is given of the botanical geography of the two last-mentioned districts; and Dr. de Wildeman dissents from Scott Elliot's view that the Tanganyika basin forms botanically merely a part of the great western Congo-Niger area, but regards it as an area with very special characters.

The Upper Katanga is described in greater detail, and some features of its vegetation are illustrated by a number of photographic reproductions. Dr. de Wildeman insists on the importance of the conservation of the forests; the number of useful species at present known is not great, but forestry investigations will probably reveal others. A large portion of the volume is occupied with a systematic enumeration of the flowering plants already known from the area; these number about 1900, but probably represent less than half the actual flora. A map of the whole district, indicating its relation to surrounding districts, would have been a useful addition.

Technique des Pétroles. By R. Courau. Pp. 406 + 19 Plates. (Paris: Octave Doin, 1921.) Price 16 francs.

Practically every phase of petroleum technology is covered by this volume, and as a general text-book it will be of considerable utility. Much of the subject matter is treated somewhat summarily, particularly in the geological section; in fact this suffers from undue brevity when contrasted with the engineering and chemical aspects of the science.

The arrangement of the text is systematic, and it is primarily divided into two books, the first dealing with the geology and economic development of petroleum, and the second with its chemical and physical properties, methods of refining, storage, and transport. Unlike many books of this description, there is no overcrowding with tables of constants, statistics, etc., and space is therefore available for a consideration of certain technical operations which either receive scanty treatment or are omitted altogether from similar publications elsewhere. We should have preferred, however, the inclusion of the figures in the text rather than in their less convenient form of plates at the end of the book, while the omission of a detailed index is also rather unfortunate. Apart from this and the fact that the present rate of exchange makes the book an extremely cheap purchase in this country, it is well worth reading, if only to obtain the French view of current oilfield development and refinery technique.

H. B. Milner.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Discoveries in Tropical Medicine.

IT is a matter for regret that the obituary notice of a well-known medical man should be used to put forward a statement of his share in the progress of knowledge which is misleading. It is necessary to correct such a statement when it is conspicuous and likely to be accepted as truthful. In a brief biography of the late Sir Patrick Manson in the *Times* of April 10, it is stated that "modern tropical medicine" was born when he suggested that the *Filaria sanguinis hominis*—discovered some years previously by Dr. Timothy Lewis in persons afflicted with elephantiasis —"is taken from one person to another by mosquitoes." On the ground that this was the first suggestion as to the carriage of disease-germs by mosquitoes, *and was well founded*, the chief merit in the later discoveries of the part played by those insects in the transmission of malaria and of yellow fever is attributed by the *Times* to Sir Patrick Manson.

This, however, is a misapprehension, the propagation of which must do injustice and falsify history. The fact is that Manson's "suggestion" that the Filaria of elephantiasis is actually carried by mosquitoes from the blood of one person to that of another remains to this day a "suggestion." It has not been established as a fact.

Another important misconception enunciated in the same article is that no suggestion as to the mode of entry of the malaria parasite into the blood of human beings was made until Manson, fourteen years after their discovery by Laveran, "suggested" mosquitoes as the carriers. The fact, on the contrary, is that Laveran himself had stated this to be a possible and not improbable mode of transmission, and that the notion was long ago prevalent in India. The man who actually "discovered" the fact of the carriage of malaria germs by a mosquito and the particular species (*Anopheles maculipennis*) so concerned, as well as important facts as to the multiplication of the malarial parasite in the gnat's body, is Sir Ronald Ross.

Finally, the *Times* states that General Sir David Bruce is a disciple of Sir Patrick Manson. This is a peculiarly unfortunate assertion, for it makes it necessary to state the fact, well known to their colleagues, that Bruce, so far from being a disciple of Manson, disapproved of his suggestions and of his methods. The man of genius who discovered and finally abolished Malta fever, who by laborious years of work in Africa gave us solid and absolutely new knowledge of the Tsetze fly and Trypanosome diseases, nagana and sleeping-sickness—not to mention his war work in conjunction with pupils and colleagues on tetanus and on trench fever—was not in any way, directly or indirectly, influenced by or associated with Sir Patrick Manson. The attempt to associate the discoveries of Bruce with the Manson legend is a mere assertion regardless of fact and of the pain which it must cause to the friends of both.

E. RAY LANKESTER.

April 17.

Atmospheric Refraction.

IN NATURE of August 11, 1921, p. 745, appeared my letter in which I criticised a result stated by Mr. Mallock in NATURE of June 9, p. 456; and also a further brief letter by Mr. Mallock. Further letters have appeared by Dr. Ball (January 5, p. 8) and Instr. Commander Baker, R.N. (January 5, p. 8, and January 26, p. 105). In his second letter Mr. Mallock says that "the pressure gradient near the ground, and the density and refractive-index gradients also, decrease linearly at such a rate that if the linear relation continues to hold, the pressure and density would be zero and the refractive index unity at height H." This statement is incorrect as regards the density and refractive-index gradients, except in the special case when the temperature gradient is zero.

The relation between density and refractive index, $\mu-1=K\rho$, where K is constant ($=222 \cdot 16$ for sodium line D), shows that $d\mu/dh=Kd\rho/dh$, and so it is only necessary to consider the density gradient. Using suffixes $_1$, $_0$ to indicate values at sea level and at the upper limit of the atmosphere, the height H of the homogeneous atmosphere is given by $\int_1^0 \rho g dh = \rho_1 g_1 H = p_1$. Hence $p_1/H=\rho_1 g_1$, and by the ordinary mechanical law of equilibrium this is equal to $-(dp/dh)_1$, proving Mr. Mallock's statement as regards the pressure gradient.

Now if the absolute temperature near the level considered (sea level) is given by $t=t_1(1-\alpha h)$, then $p=Ct\rho=Ct_1(1-\alpha h)\rho$, which differentiated logarithmically gives for $h=0$, $(d\rho/dh)_1=-\rho_1(1-H\alpha)/H$. This result agrees with Mr. Mallock's only when $\alpha=0$, that is, when the temperature gradient is zero.

The curvature $1/\sigma$ of a ray inclined at an angle ϕ to the vertical is derived from $\mu r \sin\phi=\text{constant}$, $d\psi=d\phi+\sin\phi ds/r$, whereby $1/\sigma=d\psi/ds=-K\sin\phi d\rho/dh=(1-H\alpha)\sin\phi \,.\, K\rho/H=(1-H\alpha)\sin\phi(\mu-1)/H$, a result applicable to any point of the ray if H is understood to mean the height of the homogeneous atmosphere, of density ρ at the point, above the point. Here again agreement with Mr. Mallock is obtained if $\alpha=0$ and $\phi=90°$, *i.e.* for a horizontal ray.

Introducing the temperature gradient $\beta=t_1\alpha$, we see that $H\alpha=C\beta/g_1=29 \cdot 28\beta g_{45}/g$. Also $(\mu-1)/H$ varies as Bg/t^2, B being the barometer reduced reading. Hence

$$\frac{1}{\sigma}=3 \cdot 665\times10^{-5}\frac{B}{760}\cdot\frac{g}{g_{45}}(1+at)^{-2}\left(1-29 \cdot 28\beta'\frac{g_{45}}{g}\right)\sin\phi,$$

where $a=1/273$, β' is fall of temperature t per metre, and σ is in kilometres. No mention has been made of humidity for the reason that its action is chiefly to modify the temperature gradient, which has been allowed for.

If we multiply $1/\sigma$ by the earth's mean radius, 6371 km., we obtain $2k$, according to the Indian definition of coefficient of refraction k; or k, according to the continental definition. The result is to change the numerical factor in $1/\sigma$ into $0 \cdot 2335$. This agrees well with Jordan's formula quoted by Dr. Ball, which I had not previously seen and which, I believe, has never been used by surveyors. For $B=760$ mm. and latitude 45° we can write

$$\sigma=27285\,(1+at)^2(1-29 \cdot 28\beta')^{-1}\operatorname{cosec}\phi \text{ kilometres.}$$

The following table gives values of the radius of curvature σ in miles of a horizontal ray at level $B=760$ mm., and the coefficient of refraction as defined in India.

Gradient. Degrees Centigrade per metre.	σ in miles.		k (Indian).	
	$t=0°$	$t=10°$	$t=0°$	$t=10°$
0·000 (isothermal) .	16,980	18,220	0·117	0·109
0·006 (average) .	20,600	22,100	0·096	0·090
0·010 (adiabatic) .	24,000	25,760	0·082	0·077
0·03414	infinite		zero	

Mr. Mallock's value, 14,900 geographical miles = 17,150 miles, agrees nearly with the isothermal value for $t=0°$. (In my former letter I had not recognised that Mr. Mallock's result was in nautical miles.) The result is too small as a usual value, because he takes the temperature gradient as zero and the surface temperature to be freezing point. Dr. Ball's explanation is incorrect as pointed out by Commander Baker (January 26); and further in that he states in his second paragraph that the difficulty is not to be got over by any consideration of temperature gradient.

Commander Baker, in his letter (January 5) has arrived at a similar result, for a horizontal ray, as I have. The temperature gradient, however, of 1° C. per 200 feet, which he says will give my results, is in error; it should be per 600 feet.

In the second paragraph of this letter, Commander Baker says that neither Mr. Mallock nor I give an adequate presentation of the facts, in that the assumption is made that the ray is circular. I do not think that this deduction can be made rightly from my former letter of August 11. I may say at once that I entirely agree that the ray is not in general circular, especially when the ray is close to the earth or sea surface. However, in cases met with in land surveys (excepting rays which continue very close to the ground) one may *compute the refraction practically* by the use of a coefficient of refraction which represents the curvature at height $(2h_a+h_b)/3$, as stated in my letter. The use of different coefficients of refraction for different heights essentially involves the idea of a ray of varying curvature except in the case of a truly horizontal ray.

Now work on the diurnal change of refraction on inclined rays shows up the importance of the varying conditions of temperature gradient in the layers near the earth. I have not yet been able to reduce the case of rays, which lie mostly or largely in these lower layers, to a formula, though I think there is fair hope of doing so in some cases. Extreme cases, in which there is obvious and varying mirage, will not be amenable to treatment: but I think a ray, 20 feet above the surface, probably will. But I gather that Commander Baker is chiefly interested in rays over the sea, at a height of 30 feet or less. In the Survey of India such cases naturally do not arise, and I have not had any observations of this kind to consider. However, in my Professional Paper No. 14 (Survey of India) I have given some deductions as regards dip of the horizon (*vide* pp. 96-100), arriving at the formula

Dip in seconds from point at height $h=$

$$56{\cdot}33(h'-15{\cdot}13\Delta t')^{\frac{1}{2}}$$

where $\Delta t'=\mathrm{F}\Delta t$, $h'=h(1-0{\cdot}2204\mathrm{F})/0{\cdot}7796$, $\mathrm{F}=519{\cdot}4/t$, $t+\Delta t$ and t being the absolute temperatures at levels of observer and sea respectively. This formula is based on $\cos(\text{dip})=(1+h/r)^{-1}\mu_0/\mu$ which involves only the terminal values of μ.

I have tabulated the corresponding dip in Tab. LIII. *loc. cit.* for various values of h' and $\Delta t'$, and I should be very interested to hear from Commander Baker or others to what extent my formula represents the facts of observations. J. de Graaff Hunter.

Survey of India, Dehra Dun, U.P., India, March 2.

I agree with Dr. Hunter that my letter of January 5 contained a numerical error when I stated that a temperature gradient of 1° C. per 200 feet would give a ray curvature corresponding to the refraction coefficient given in his letter of August 11, 1921.

Dr. Hunter also takes me to task for my comment that both he and Mr. Mallock assume the refracted ray to be circular. I think I have a certain amount of justification for this, as in his letter of August 11 he speaks of the curvature of the ray "tacitly assumed to be circular," although later it is true that he states that the coefficient of refraction has different values at different heights.

It was rather in connection with the formulæ upon which the nautical tables for the dip of the sea horizon are based that I take exception to any assumption that adequate results can be obtained unless variations of curvature are considered.

As stated in my letter of January 5, it is impossible to draw a circle which touches the surface of the sea and also becomes horizontal at a height of say 30 feet above the sea, and unless consideration is given to a form of ray path that can satisfy these conditions it is impossible to get a zero value for the dip.

Dr. Hunter quotes from his Professional Paper No. 14 (Survey of India) a formula which he has set out there from which the dip is to be evaluated, and asks to what extent this formula represents the facts of observations. I have, unfortunately, no data of measurement of the dip made in connection with the temperatures of the sea level and at the bridge, but on theoretical grounds I cannot admit that this formula is correct. It will be seen that the dip becomes zero whenever $h'=15{\cdot}13\Delta t'$, which is equivalent to saying that, if the temperature rises uniformly 1° F. per 15 feet, the dip is zero at all heights. Consider now what will happen to a ray of light which starts off from the surface of the sea tangentially. In an atmosphere of uniform refractive index that ray would proceed in a straight line and ultimately depart from the earth entirely. With a refractive index that diminishes with height the ray will be bent towards the earth, and if the rate of diminution is great enough that ray will at some point become horizontal and the dip will be zero. Let us say that this point is at a height of 30 feet above the sea. Dr. Hunter's formula requires that the temperature should be 2° more at 30 feet than at sea level, and if the rise of temperature is uniform in this 30 feet his formula also requires that the dip should be zero, and therefore the ray horizontal, at all heights below 30 feet. This is obviously a fallacy, for if the ray was always horizontal it would never reach the height of 30 feet at all.

The fact is that in an atmosphere where the layers of uniform refractive index are spheres concentric with the earth, the dip can only be zero, if at all, at one height. Below that height the dip will be positive with a maximum value at some lower level; above that height no ray tangential to the earth's surface can be seen at all, and the depression or elevation of the sea horizon requires an entirely different explanation.

The equation upon which Dr. Hunter's formula is based brings out this point quite clearly. This equation is

$$\text{Cos (dip)}=\mu_0 r/\mu(r+h).$$

In an atmosphere in which $\mu(r+h)$ is, at some height, less than $\mu_0 r$ the dip becomes imaginary, for its cosine is greater than unity. The dip could only be zero for all heights for an atmosphere in which $\mu(r+h)$ is constant, and in such case a ray once horizontal would remain horizontal for a complete circuit of the earth. Thos. Y. Baker.

Admiralty Research Laboratory,
Teddington, Middlesex, April 6.

Memory.

MEMORY is the power to learn, to grow mentally in response to functional activity, to profit from experience, and so to become intelligent. It has its counterpart in the power to develop physically in response to use. Its evolution occurred especially among the higher animals, and was accompanied by a general retrogression of instinct. Nevertheless, at least four new instincts were evolved, each of which incites to learning, and without which little or no intelligence could develop, no matter how great the capacity to learn.

(1) The parental instinct incites to the protection and training of offspring. It wanes when offspring are fit to fend for themselves.

(2) The instinct of sport impels the individual to develop both body and mind in exactly the right directions. Thus the kid climbs and butts, and the kitten stalks and pounces. This instinct wanes as the individual reaches maturity and ability to battle for existence. It lingers longest in human beings who remain capable of some mental development even to old age. But the character of human sport gradually changes from those contests of strength and endurance which developed the boy to those which merely maintain physical development, or else are pure contests of skill and wit. Thus the mature man ceases to wrestle, and amuses himself instead with golf, bowls, cards, and the like.

(3) The instinct of imitation incites the individual to learn (from the examples furnished by his companions) how to act and what to think. It often works in combination with play (for much play is mimicry), and wanes in the individual even more swiftly and in a greater degree than the latter. While it persists in strength the individual is termed "plastic." It is best developed in man, who learns through imitation not only such habitual actions as walking and speaking a language, but also the habits of thought, the general outlooks on life, the ambitions, and the emotional convictions as to what is true and right that distinguish the community (or section of it) in which he is reared, savage or civilised, Christian or Mohammedan, Catholic or Protestant, lowly or exalted, and so on. In this way he fits himself for life in that particular environment. Thus, mainly, is fashioned what is termed his "character," his general mental disposition. As the twig is bent, so the tree grows. Hence the importance of good homes, companions, and schools. As this instinct wanes the character sets. The same kind of things are no longer learned, at any rate to the same extent and with equal facility. Compare language as learned by a child and by an adult. It follows that the traits created by imitation tend to be very stable, for they are not afterwards displaced by others of the same kind. The boy becomes the father of the man.

(4) The instinct of curiosity impels the individual to seek for, and learn from, evidence. Unlike imitation, it persists with relatively little diminution even to old age. To it (and to labour) the individual owes the main part of his mental development after childhood, his intelligence, his reason. It creates, not sentimental, but intellectual convictions. Since it persists during life, the ideas acquired through it tend to be unstable—apt to be displaced by others which seem founded on superior evidence.

(5) Apart from instinct, man, especially civilised man, has invented labour, to which he is impelled by the intelligence created through his memory, and from which he learns to become yet more intelligent, efficient, and laborious. Thus, as indicated by Prof. Goodrich, in the mental, as in the physical, world each stage of development furnishes the basis for the next until full development is achieved. Labour commonly lacks the pleasure and interest which accompany the instinctive activities. Thus, while men never delegate the latter (*e.g.* eating, sporting, and love-making) to others, they often delegate the labours to which they are prompted by intelligence. Like play and imitation, but unlike curiosity, labour tends to create habitual "physical" dexterities—which are really mental, for the (subconscious) mind co-ordinates the muscles. On the other hand, the intellectual traits created by labour resemble those created by curiosity.

We are concerned especially with the products of imitation and curiosity. All the rest of the "make-up" of man's mind is relatively simple and obvious. His instincts, few in number and definite in character, are identical in kind for all men. At most this man or this race may have this instinct or that (*e.g.* the sexual or parental) more or less developed than this or that other. Again, all men except idiots are eminently educable. They differ in capacities for learning, but yet more in the way in which the capacity is used. Apart from play and labour, the results of which are glaringly obvious, men learn only through imitation and curiosity; and accordingly as they acquire more through the one than through the other, their characters are shaped and the fates of nations decided. Here must the parent and the pedagogue learn or be impotent. Here must the man of science labour, or charlatans and fanatics will for ever dominate the body politic.

The mental traits created by imitation and curiosity differ sharply. Not only are convictions derived from example very stable, but they are tinged with emotion, and even passion. The reverse is the case with those derived from evidence. Compare moral and religious convictions, which belong to the former category, with business and scientific beliefs, which belong to the latter. A religious and ethical system may conflict daily with common sense (*i.e.* evidence), and yet persist for a hundred generations. But the knowledge and ideas acquired through curiosity change in every man with every year. When men believed on grounds of faith (*i.e.* through imitation) that the world was flat they burned dissentients; to-day, when they believe on grounds of fact (*i.e.* on grounds of evidence) that it is round, they are contemptuously indifferent. Every missionary knows the ease with which the children of non-Christians may be trained to his beliefs and ideals, and the difficulty and danger of trying to convert adults. A child who is taught that honesty is right will for ever hold that opinion; an adult taught that honesty is the best policy may easily change. If there be such things as absolute right and wrong, the human mind is incapable of knowing them; for the conscience, chameleon-like, is a product of imitation. Thus at different times and places everything, from promiscuous sexual intercourse to rigid abstention from all intercourse, has been held holy, or permissible, or damnable, and conscience has pricked men correspondingly.

The traits created by imitativeness—habitual emotions and ways of acting—resemble closely the instinctive emotions and actions. Thus men and horses walk, men and ants are social, men and bees defend their communities; but while the men have learned, the others have not. The love of a human mother for her baby is instinctive, that for her mature offspring is habitual; yet the one passes insensibly into the other. Did we not know that the children of Mohammedans could be trained to other beliefs and ideals we might think the fanaticism of the adults instinctive. So closely do habitual actions and

emotions resemble their instinctive prototypes that they are often thus described—as when a woman shrinks from untruth or a caterpillar, or when a boy dodges a blow. Habits are, in fact, pseudo-instincts; they have the same function; they are substitutes. Unlike real instincts, they are not infallibly useful, but, on the whole, they are superior, for they fit the individual to his particular environment, and, since they may change in future generations otherwise than by slow processes of natural selection, may be improved more rapidly.

On the other hand, the traits created by curiosity bear no resemblance to instincts. They are intellectual, not emotional. In the little child the two instincts work hand in hand, but in the adult they are often opposed; for the traits derived from imitation (faith, right belief, and morality, as we term them in ourselves; bias, prejudice, fanaticism, and superstition, as we call them in others) may prevent the development of those traits which curiosity should bestow—as is best seen among savages, creatures of custom and emotion, who, following from age to age in the ancestral footsteps, add little to their command over nature. Among modern civilised peoples the ecclesiastical mind is especially a product of imitation, the scientific mind of curiosity. Consider how unlike they are, and how different all societies trained mainly through imitation (*e.g.* medieval Christians and modern Mohammedans) are from those trained through curiosity (*e.g.* ancient Greeks and the more "enlightened moderns").

G. Archdall Reid.

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Walaeus and the Circulation of the Blood.

It has been my good fortune to come across two epistles written by Johannes Walaeus (1604–1649), professor of medicine in the University of Leyden in the year 1640. The two epistles occur at the end of Bartholini's "Anatomy," published by Nich. Culpeper, Gent., and Abdiah Cole, Doctor of Physick: printed (in English) by Peter Cole; London, 1665.

Walaeus was greatly interested in the discovery of the circulation of the blood by Harvey, and in order to confirm it performed a large number of experiments on dogs, cats, rabbits, and monkeys. Having arrived at the conclusion already reached by Harvey, that the blood does not move itself, but is driven, he asks the questions "How is it driven?" and "What is the mechanism?" The answer is given in these two epistles written by Johannes Walaeus to his friend Bartholini, the professor of anatomy at the University of Copenhagen, and is as follows:—

"And that the Blood is driven by the *Vena Cava* into *the right Earlet of the Heart*, I have manifestly seen in the dissection of live Creatures: for in all motions of the Heart, the first beginning of Motion is so or no, because the Cava was knit to the Earlet [*i.e.* Auricle] and the Heart, we cut the Heart and the Earlet quite off in living Dogs, at the *Vena Cava*, and we observed, that even then the *Vena Cava* did a very little pulse, and at every time did send forth a little Blood. And therefore the *Vena Cava* hath certain fleshy fibres, for the most part about the Heart, which elsewhere you shall not find in *Vena Cava*. Now the motion of the *Vena Cava* is most evident near the Heart."

Writing in 1913 Sir James Mackenzie says: "Until very recent times no definite remains of the sinus venosus had been found. Keith and Clark have described a small node of tissue—the sino-auricular node—at the mouth of the superior vena cava. This tissue consists of fine, delicate, pale fibres faintly striated." In the same year Dr. (now Sir Thomas) Lewis tells us that "the wave of contraction starts in a small and newly discovered mass of tissue the sino-auricular node, which lies embedded in the upper and anterior end of the sulcus terminalis."

On the subject of auricular fibrillation Walaeus is also very interesting for he tells us that "the Impulse into both Earlets and into both Ventricles happens at one and the same moment of time; save in Creatures ready to die, in which we have observed that both Earlets, and both Ventricles do not pulse at one and the same time. But when the Blood is thus driven into the Ventricles of the Heart, the Heart hath no motion evident to the Eye, but putting our Finger upon the Heart we perceive something to enter into the Heart, and that the Heart becomes fuller, which also Harvey hath observed. Yea, we have observed that the Earlet hath pulsed seventy, sometimes an hundred pulses before any motion of the Heart followed." Somewhat similar observations had, however, already been made by Harvey ("De motu cordis et sanguinis," 1628, Chapter IV.).

G. Arbour Stephens,
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61 Walter Road,
Swansea,
April 2.

Transcription of Russian Names.

Some 35 years ago I made in the columns of Nature the proposal to adopt for the transcription of Russian names a few letters from the Bohemian alphabet. My letter was submitted to the authority of the editor of the Journal of the Chemical Society (for I was at that time Abstractor of that Journal for Russian literature), but he did not agree with my proposal, though later he accepted it for the Journal.

I beg to repeat my old proposal; for a great part of Russian scientific life is concentrated in Prague, and the Bohemian mode of transcription has, moreover, been accepted by philologists and by many geographers. Bohemian is now the State-tongue of an independent State. It is necessary to introduce only the following few letters: č = tch, ď = dj, ě = ye, ch = kh, ň = nj, š = sh, ť = tj, and ž = zh (joli); á = long a, and if you add the Bohemian ř which has two pronounciations: rž and rš, you can pronounce also all Bohemian names.

The following comparison between the old and new mode of spelling shows that the latter has also the advantage of a great economy in printing:

Tchitcherine (12)	= Čičerin (7)
Zhemtchuzhnyj (13)	= Žemčužnyj (9)
Mendeleeff	= Mendělějev
Konj (4)	= Koň (3)
Tatjana (8)	= Taťána (6)
Pushkine (8)	= Puškin (6)
Djadja (6)	= Ďáďa (4)
Metchnikoff (11)	= Měčnikov (8).

Bohuslav Brauner.

Chemical Laboratory,
Bohemian University, Prague,
March 9.

Evolutionary Faith and Modern Doubts.[1]

By W. Bateson, F.R.S.

I VISIT Canada for the first time in delightful circumstances. After a period of dangerous isolation, intercourse between the centres of scientific development is once more beginning, and I am grateful to the American Association for this splendid opportunity of renewing friendship with my western colleagues in genetics, and of coming into even a temporary partnership in the great enterprise which they have carried through with such extraordinary success.

In all that relates to the theme which I am about to consider we have been passing through a period of amazing activity and fruitful research. Coming here after a week in close communion with the wonders of Columbia University, I may seem behind the times in asking you to devote an hour to the old topic of evolution. But though that subject is no longer in the forefront of debate, I believe it is never very far from the threshold of our minds, and it is with pleasure that I find it appearing in conspicuous places in several parts of the programme of this meeting.

Standing before the American Association, it is not unfit that I should begin with a personal reminiscence. In 1883 I first came to the United States to study the development of Balanoglossus at the Johns Hopkins summer laboratory, then at Hampton, Virginia. This creature had lately been found there in an easily accessible place. With a magnanimity that on looking back I realise was superb, Prof. W. K. Brooks had given me permission to investigate it, thereby handing over to a young stranger one of the prizes which in this age of more highly developed patriotism, most teachers would keep for themselves and their own students. At that time one morphological laboratory was in purpose and aim very much like another. Morphology was studied because it was the material believed to be most favourable for the elucidation of the problems of evolution, and we all thought that in embryology the quintessence of morphological truth was most palpably presented. Therefore every aspiring zoologist was an embryologist, and the one topic of professional conversation was evolution. It had been so in our Cambridge school, and it was so at Hampton.

I wonder if there is now a single place where the academic problems of morphology which we discussed with such avidity can now arouse a moment's concern. There were of course men who saw a little further, notably Brooks himself. He was at that time writing a book on heredity, and, to me at least, the notion on which he used to expatiate, that there was a special physiology of heredity capable of independent study, came as a new idea. But no organised attack on that problem was begun, nor had any one an inkling of how to set about it. So we went on talking about evolution. That is barely 40 years ago; to-day we feel silence to be the safer course.

Systematists still discuss the limits of specific distinction in a spirit which I fear is often rather scholastic than progressive, but in the other centres of biological research a score of concrete and immediate problems have replaced evolution.

Discussions of evolution came to an end primarily because it was obvious that no progress was being made. Morphology having been explored in its minutest corners, we turned elsewhere. Variation and heredity, the two components of the evolutionary path, were next tried. The geneticist is the successor of the morphologist. We became geneticists in the conviction that there at least must evolutionary wisdom be found. We got on fast. So soon as a critical study of variation was undertaken, evidence came in as to the way in which varieties do actually arise in descent. The unacceptable doctrine of the secular transformation of masses by the accumulation of impalpable changes became not only unlikely but gratuitous. An examination in the field of the interrelations of pairs of well-characterised but closely allied "species" next proved, almost wherever such an inquiry could be instituted, that neither could both have been gradually evolved by natural selection from a common intermediate progenitor, nor either from the other by such a process. Scarcely ever where such pairs co-exist in nature, or occupy conterminous areas do we find an intermediate normal population as the theory demands. The ignorance of common facts bearing on this part of the inquiry which prevailed among evolutionists was, as one looks back, astonishing and inexplicable. It had been decreed that when varieties of a species co-exist in nature, they must be connected by all intergradations, and it was an article of faith of almost equal validity that the intermediate form must be statistically the majority, and the extremes comparatively rare. The plant breeder might declare that he had varieties of Primula or some other plant, lately constituted, uniform in every varietal character and breeding strictly true in those respects, or the entomologist might state that a polymorphic species of a beetle or of a moth fell obviously into definite types, but the evolutionary philosopher knew better. To him such statements merely showed that the reporter was a bad observer, and not improbably a destroyer of inconvenient material. Systematists had sound information, but no one consulted them on such matters or cared to hear what they might have to say. The evolutionist of the 'eighties was perfectly certain that species were a figment of the systematist's mind, not worthy of enlightened attention.

Then came the Mendelian clue. We saw the varieties arising. Segregation maintained their identity. The discontinuity of variation was recognised in abundance. Plenty of the Mendelian combinations would in nature pass the scrutiny of even an exacting systematist and be given "specific rank." In the light of such facts the origin of species was no doubt a similar phenomenon. All was clear ahead. But soon, though knowledge advanced at a great rate, and though whole ranges of phenomena which had seemed capricious and disorderly fell rapidly into a co-ordinated system, less and less was heard about evolution in genetical circles, and now the topic is dropped. When students of other

[1] Address delivered before the American Association for the Advancement of Science at Toronto on December 28, 1921.

sciences ask us what is now currently believed about the origin of species we have no clear answer to give. Faith has given place to agnosticism for reasons which on such an occasion as this we may profitably consider.

Where precisely has the difficulty arisen? Though the reasons for our reticence are many and present themselves in various forms, they are in essence one; that as we have come to know more of living things and their properties, we have become more and more impressed with the inapplicability of the evidence to these questions of origin. There is no apparatus which can be brought to bear on them which promises any immediate solution.

In the period I am thinking of, it was in the characteristics and behaviour of animals and plants in their more familiar phases, namely, the zygotic phases, that attention centred. Genetical research has revealed the world of gametes from which the zygotes—the products of fertilisation—are constructed. What has been there witnessed is of such extraordinary novelty and so entirely unexpected that in the presence of the new discoveries we would fain desist from speculation for while. We see long courses of analysis to be travelled through and for some time to come that will be a sufficient occupation. The evolutionary systems of the eighteenth and nineteenth centuries were attempts to elucidate the order seen prevailing in this world of zygotes and to explain it in simpler terms of cause and effect: we now perceive that that order rests on and is determined by another equally significant and equally in need of "explanation." But if we for the present drop evolutionary speculation it is in no spirit of despair. What has been learned about the gametes and their natural history constitutes progress upon which we shall never have to go back. The analysis has gone deeper than the most sanguine could have hoped.

We have turned still another bend in the track and behind the gametes we see the chromosomes, for the doubts—which I trust may be pardoned in one who had never seen the marvels of cytology, save as through a glass darkly—cannot, as regards the main thesis of the Drosophila workers, be any longer maintained. The arguments of Morgan and his colleagues, and especially the demonstrations of Bridges, must allay all scepticism as to the direct association of particular chromosomes with particular features of the zygote. The transferable characters borne by the gametes have been successfully referred to the visible details of nuclear configuration.

The traces of order in variation and heredity which so lately seemed paradoxical curiosities have led step by step to this beautiful discovery. I come at this Christmas season to lay my respectful homage before the stars that have arisen in the west. What wonder if we hold our breath? When we knew nothing of all this the words came freely. How easy it all used to look! What glorious assumptions went without rebuke. Regardless of the obvious consideration that "modification by descent" must be a chemical process, and that of the principles governing that chemistry, science had neither hint, nor surmise, nor even an empirical observation of its working, professed men of science offered positive opinions very confidently on these nebulous topics which would now scarcely pass muster in a newspaper or a sermon. It is a wholesome sign of return to sense that these debates have been suspended.

Biological science has returned to its rightful place, investigation of the structure and properties of the concrete and visible world. We cannot see how the differentiation into species came about. Variation of many kinds, often considerable, we daily witness, but no origin of species. Distinguishing what is known from what may be believed, we have absolute certainty that new forms of life, new orders and new species have arisen on the earth. That is proved by the palæontological record. In a spirit of paradox even this has been questioned. It has been asked how do you *know* for example that there were no mammals in palæozoic times? May there not have been mammals somewhere on the earth though no vestige of them has come down to us? We may feel confident there were no mammals then, but are we sure? In very ancient rocks most of the great orders of animals are represented. The absence of the others might by no great stress of imagination be ascribed to accidental circumstances.

Happily, however, there is one example of which we can be sure. There were no Angiosperms—that is to say, "higher plants" with protected seeds—in the carboniferous epoch. Of that age we have abundant remains of a world-wide and rich flora. The Angiosperms are cosmopolitan. By their means of dispersal they must immediately have become so. Their remains are very readily preserved. If they had been in existence on the earth in carboniferous times they must have been present with the carboniferous plants, and must have been preserved with them. Hence we may be sure that they did appear on the earth since those times. We are not certain, using certain in the strict sense, that the Angiosperms are the lineal descendants of the carboniferous plants, but it is very much easier to believe that they are than that they are not.

Where is the difficulty? If the Angiosperms came from the carboniferous flora why may we not believe the old comfortable theory in the old way? Well so we may, if by belief we mean faith, the substance, the foundation of things hoped for, the evidence of things not seen. In dim outline evolution is evident enough. From the facts it is a conclusion which inevitably follows. But that particular and essential bit of the theory of evolution which is concerned with the origin and nature of *species* remains utterly mysterious. We no longer feel as we used to do, that the process of variation, now contemporaneously occurring, is the beginning of a work which needs merely the element of time for its completion; for even time cannot complete that which has not yet begun. The conclusion in which we were brought up, that species are a product of a summation of variations, ignored the chief attribute of species, that the product of their crosses is frequently sterile in greater or less degree. Huxley very early in the debate pointed out this grave defect in the evidence, but before breeding researches had been made on a large scale no one felt the objection to be serious. Extended work might be trusted to supply the deficiency. It has not done so, and the significance of the negative evidence can no longer be denied.

When Darwin discussed the problem of inter-specific sterility in the "Origin of Species" this aspect of the

matter seems to have escaped him.[1] He is at great pains to prove that inter-specific crosses are *not always* sterile, and he shows that crosses between forms which pass for distinct species may produce hybrids which range from complete fertility to complete sterility. The fertile hybrids he claims in support of his argument. If species arose from a common origin, clearly they should not always give sterile hybrids. So Darwin is concerned to prove that such hybrids are by no means always sterile, which to us is a commonplace of every-day experience. If species have a common origin, where did they pick up the ingredients which produce this sexual incompatibility? Almost certainly it is a variation in which something has been added. We have come to see that variations can very commonly—I do not say always—be distinguished as positive and negative. The validity of this distinction has been doubted, especially by the Drosophila workers. Nevertheless in application to a very large range of characters, I am satisfied that the distinction holds, and that in analysis it is a useful aid. Now we have no difficulty in finding evidence of variation by loss. Examples abound, but variations by addition are rarities, even if there are any which must be so accounted. The variations to which inter-specific sterility is due are obviously variations in which something is apparently added to the stock of ingredients. It is one of the common experiences of the breeder that when a hybrid is partially sterile, and from it any fertile offspring can be obtained, the sterility, once lost, disappears. This has been the history of many, perhaps most of our cultivated plants of hybrid origin.

The production of an indubitably sterile hybrid from completely fertile parents which have arisen under critical observation from a single common origin is the event for which we wait. Until this event is witnessed, our knowledge of evolution is incomplete in a vital respect. From time to time a record of such an observation is published, but none has yet survived criticism. Meanwhile, though our faith in evolution stands unshaken, we have no acceptable account of the origin of "species."

Curiously enough, it is at the same point that the validity of the claim of natural selection as the main directing force was most questionable. The survival of the fittest was a plausible account of evolution in broad outline, but failed in application to specific difference. The Darwinian philosophy convinced us that every species must "make good" in nature if it is to survive, but no one could tell how the differences—often very sharply fixed—which we recognise as specific, do in fact enable the species to make good. The claims of natural selection as the chief factor in the determination of species have consequently been discredited.

I pass to another part of the problem, where again, though extraordinary progress in knowledge has been made, a new and formidable difficulty has been encountered. Of variations we know a great deal more than we did. Almost all that we have seen are variations in which we recognize that elements have been lost. In addressing the British Association in 1914 I dwelt on evidence of this class. The developments of the last seven years, which are memorable as having provided in regard to one animal, the fly Drosophila, the most comprehensive mass of genetic observation yet collected, serve rather to emphasise than to weaken the considerations to which I then referred. Even in Drosophila, where hundreds of genetically distinct factors have been identified, very few new dominants, that is to say positive additions, have been seen, and I am assured that none of them are of a class which could be expected to be viable under natural conditions.

If we try to trace back the origin of our domesticated animals and plants, we can scarcely ever point to a single wild species as the probable progenitor. Almost every naturalist who has dealt with these questions in recent years has had recourse to theories of multiple origin, because our modern races have positive characteristics which we cannot find in any existing species, and which combinations of the existing species seem unable to provide. To produce our domesticated races it seems that ingredients must have been added. To invoke the hypothetical existence of lost species provides a poor escape from this difficulty, and we are left with the conviction that some part of the chain of reasoning is missing. The weight of this objection will be most felt by those who have most experience in practical breeding. I cannot, for instance, imagine a round seed being formed on a wrinkled variety of pea except by crossing. Such seeds, which look round, sometimes appear, but this is a superficial appearance, and either these seeds are seen to have the starch of wrinkled seeds or can be proved to be the produce of stray pollen. Nor can I imagine a fern-leaved Primula producing a palm-leaf, or a star-shaped flower producing the old type of *sinensis* flower. And so on through long series of forms which we have watched for twenty years.

Analysis has revealed hosts of transferable characters. Their combinations suffice to supply in abundance series of types which might pass for new species, and certainly would be so classed if they were met with in nature. Yet, critically tested, we find that they are not distinct species, and we have no reason to suppose that any accumulations of characters of the same order would culminate in the production of distinct species. Specific difference therefore must be regarded as probably attaching to the base upon which these transferables are implanted, of which we know absolutely nothing at all. Nothing that we have witnessed in the contemporary world can colourably be interpreted as providing the sort of evidence required.

Twenty years ago, de Vries made what looked like a promising attempt to supply this so far as Oenothera was concerned. In the light of modern experiments, especially those of Renner, the interest attaching to the polymorphism of Oenothera has greatly developed, but in application to that phenomenon the theory of mutation falls. We see novel forms appearing, but they are no new species of Oenothera, nor are the parents which produce them pure or homozygous forms. Renner's identification of the several complexes allocated to the male and female sides of the several types is a wonderful and significant piece of analysis introducing us to new genetical conceptions. The Oenotheras illustrate in

[1] He refers to it, however, in "Animals and Plants," chap. xix., and adduces the sterility which he observed in several of his illegitimately raised plants of Lythrum, arguing that this sterility, arising from the crossing of co-derivatives, is comparable with that produced by the intercrossing of true species. The details are given in "Forms of Flowers," chap. v. Without more evidence the genetical nature of these plants cannot be conjectured with much confidence, but it is highly improbable that the parallel really holds.

the most striking fashion how crude and inadequate are the suppositions which we entertained before the world of gametes was revealed. The appearance of the plant tells us little or nothing of these things. In Mendelism, we learnt to appreciate the implication of the fact that the organism is a double structure, containing ingredients derived from the mother and from the father respectively. We have now to admit the further conception that between the male and female sides of the same plant these ingredients may be quite differently apportioned, and that the genetical composition of each may be so distinct that the systematist might without extravagance recognise them as distinct specifically. If then our plant may by appropriate treatment be made to give off two distinct forms, why is not that phenomenon a true instance of Darwin's origin of species? In Darwin's time it must have been acclaimed as supplying all and more than he ever hoped to see. We know that that is not the true interpretation for that which comes out is no new creation.

Only those who are keeping up with these new developments can appreciate fully their vast significance or anticipate the next step. That is the province of the geneticist. Nevertheless, I am convinced that biology would gain greatly by some co-operation among workers in the several branches. I had expected that genetics would provide at once common ground for the systematist and the laboratory worker. This hope has been disappointed. Each still keeps apart. Systematic literature grows precisely as if the genetical discoveries had never been made, and the geneticists more and more withdraw each into his special "claim"—a most lamentable result. Both are to blame. If we cannot persuade the systematists to come to us, at least we can go to them. They too have built up a vast edifice of knowledge which they are willing to share with us, and which we greatly need. They too have never lost that longing for the truth about evolution which to men of my date is the salt of biology, the impulse which made us biologists. It is from them that the raw materials for our researches are to be drawn, which alone can give catholicity and breadth to our studies. We and the systematists have to devise a common language.

Both we and the systematists have everything to gain by a closer alliance. Of course we must specialise, but I suggest to educationists that, in biology at least, specialisation begins too early. In England certainly, harm is done by a system of examinations discouraging to that taste for field natural history and collecting, spontaneous in so many young people. How it may be on this side, I cannot say, but with us attainments of that kind are seldom rewarded, and are too often despised as trivial in comparison with the stereotyped biology which can be learned from text-books. Nevertheless, given the aptitude, a very wide acquaintance with nature and the diversity of living things may be acquired before the age at which more intensive study must be begun, and is the best preparation for research in any of the branches of biology.

The separation between the laboratory men and the systematists already imperils the work, I might almost say the sanity, of both. The systematists will feel the ground fall from beneath their feet, when they learn and realise what genetics has accomplished, and we, close students of specially chosen examples, may find our eyes dazzled and blinded when we look up from our work-tables to contemplate the brilliant vision of the natural world in its boundless complexity.

I have put before you very frankly the considerations which have made us agnostic as to the actual mode and processes of evolution. When such confessions are made the enemies of science see their chance. If we cannot declare here and now how species arose, they will obligingly offer us the solutions with which obscurantism is satisfied. Let us then proclaim in precise and unmistakable language that our faith in evolution is unshaken. Every available line of argument converges on this inevitable conclusion. The obscurantist has nothing to suggest which is worth a moment's attention. The difficulties which weigh upon the professional biologist need not trouble the layman. Our doubts are not as to the reality or truth of evolution, but as to the origin of *species*, a technical, almost domestic, problem. Any day that mystery may be solved. The discoveries of the last twenty-five years enable us for the first time to discuss these questions intelligently and on a basis of fact. That synthesis will follow on an analysis, we do not and cannot doubt.

Alternating-Current Mineral Separation.[1]

By PROF. S. J. TRUSCOTT, Imperial College (Royal School of Mines), South Kensington.

INVESTIGATION of the possible use of alternating current in magnetic separation, either in the direction of obtaining a rotary field by polyphase currents, or otherwise, has hitherto not resulted in any useful discovery. Recently, however, Mr. W. M. Mordey, past president of the Institution of Electrical Engineers, by arranging poles energised by two-phase currents to follow one another across the stream, has succeeded in driving iron minerals and iron compounds in that direction. This effect is not one of ordinary magnetic attraction and repulsion, but apparently a display of "hysteretic repulsion," a repulsion consequent upon the magnetism residual after each alternation, and made continuous by the moving field contributed by polyphase current.

A laminated alternating-current magnet behaves towards magnetite or iron-filings much like a direct-current magnet, in that tufts of these materials form at the poles, from which lines of force radiate. On the other hand, towards such a feebly magnetic mineral as hæmatite no attraction appears to be exercised but a decided repulsion is witnessed, for example, when a dish containing powdered hæmatite is laid upon an upturned pole. This repulsion is continuous when the dish spans a number of poles and these are energised by polyphase current. Similar repulsion of magnetite occurs at a lower excitation or when the dish is lifted sensibly off the poles.

[1] W. M. Mordey, Transactions South African Institute of Electrical Engineers, December 1921.

From the foregoing it seems probable that ordinary magnetic attraction and hysteretic repulsion determine between them the behaviour of particles in the field of an alternating-current magnet. Of these two factors the former is fairly understood; it remains to indicate one or two points concerning the latter. Hysteretic repulsion is low and attraction relatively high when the frequency of alternation is low, and *vice versa*; Mr. Mordey found that, with an increase of frequency from 25 to 75 periods, the speed at which the material was repelled increased approximately as the square of the increase in frequency. At higher frequencies, however, repulsion appears to be again inactive; Mr. Mordey, for example, found that both at 150 periods and at 350, repulsion was not manifest but attraction, even hæmatite remaining over the poles. He used relatively low inductions, 560 to 2000, these being more proper to alternating current than the higher inductions associated with direct current in ordinary magnetic separation.

The continuous repulsion of the ferriferous particles across the stream is forceful and unhesitating, whether these particles be dry or borne in water; it is assisted by an upward repulsion which frees them from entanglement with associated gangue, and gives them power to climb an inclination or even the sides of the container. At the same time, however, these particles, and particularly those of magnetite, tend to be held strongly in the plane of their movement, so that unless the field be properly adjusted transverse walls or banks form such as hinder the escape of gangue.

To make use of this discovery Mr. Mordey has in mind a shallow inclined launder down which the material would flow in the condition of an ore-pulp. With poles running the length of this launder the ferriferous particles would be driven to one side, to be collected separately at the bottom, the gangue particles keeping a straight path.

It is interesting that only iron minerals have so far been found capable of making the transverse movement, such moderately magnetic minerals as ilmenite and wolframite not moving; it is also of interest that, though magnetite moves more strongly, hæmatite can hardly be said to be outclassed; further, a small contamination with iron oxide causes other minerals to move, wolframite and cassiterite, for instance.

Obviously, therefore, though magnetic susceptibility is doubtless involved it does not enter unfettered; as already stated, it is associated with hysteretic repulsion. That the repulsion may be due to eddy currents set up in the particles appears to be excluded by the fact that the conductivity of hæmatite is not high enough to permit any pronounced development of such currents; moreover, particles of metallic aluminium, the conductivity of which is very high, are not repelled.

It is to be hoped that this process of magnetic separation may so develop that deposits, such as that at Dunderland, Norway, which contain much hæmatite in addition to magnetite, and others consisting largely of granular hæmatite, may be successfully treated. In view of the many deposits coming within these descriptions, and of the fact that the present means of magnetic separation, good as they are for dry work, fail entirely to separate feebly-magnetic minerals from a water-borne pulp, any endeavours to realise this hope will be viewed by all with the greatest sympathy and interest. The ordinary magnetic concentration of magnetite is not an expensive treatment, but the treatment outlined by Mr. Mordey, being simplicity itself, would cost still less.

Obituary.

Prof. J. C. Branner.

Prof. John Casper Branner, president emeritus of Stanford University, California, died at Palo Alto, California, on March 1, in his seventy-second year. He was a geologist of stimulating activity, and was attracted to Brazil as a young man in 1874 through his master at Cornell, C. F. Hartt. In 1875 he succeeded Hartt as director of the Imperial Geological Commission in Brazil, and, on the establishment of the republic, continued his observations in that country on various expeditions from time to time. In 1885 he was appointed professor of geology in Indiana University, and in 1892 to the similar post in the newly founded Stanford University. He won a considerable position as an economic botanist, and his geological papers cover a wide and practical field. His "Outlines of the Geology of Brazil," the second edition of which was published in the Bulletin of the Geological Society of America as recently as 1920, has been noticed in Nature, vol. 106, p. 58. This very useful summary includes a geological map of the whole country on the scale of 1 : 5,000,000.

Many European geologists will remember Branner at the International Geological Congress in Zürich in 1894, and all who met him must have been won by his strong personality and his equally strong and manly presence. It is characteristic of his outlook that in his most recent treatise he hopes that his work may be of service to the Brazilian people, "to whom I am strongly attached, and in whose welfare I am deeply interested."

We owe some of the facts and dates in the foregoing notice to an appreciative article by Dr. David Starr Jordan in *Science* for March 31, and to an obituary notice in the *American Journal of Science* for April.

Dr. Andrew McWilliam, C.B.E.

The death of Dr. Andrew McWilliam, which occurred on April 5, came as a shock to a large circle of friends and former pupils, and deprives the steel world of a metallurgist of great knowledge and wide experience. A native of Galloway, Dr. McWilliam was educated at Allan Glen's School, Glasgow, and at the Royal School of Mines, of which he became an Associate. On leaving South Kensington, he entered the Sheffield Technical School, afterwards incorporated with the University of Sheffield, but later he left to take up in succession several outside posts. Returning to Sheffield, he was first appointed lecturer, and then assistant professor,

in metallurgy, and began that long association with Dr. Arnold in the development of the University as a centre of metallurgical education and research. Besides the work of training chemists and managers for the steel industry of the city, the two collaborators published numerous papers containing important contributions to metallurgy, and were always ready to assist local manufacturers by advice, by conducting special investigations, and when necessary by defending their patent rights against attacks.

In 1911 Dr. McWilliam left for India to become government inspector of steels in that country, and held that responsible position for six years. He then entered the Tata Iron and Steel works and for a year did excellent service in the technical reorganisation of the steel departments. On his return to Sheffield he took up a consulting practice, for which he was peculiarly qualified from his intimate knowledge of the manufacture and properties of steels of high quality. As an active member of technical societies, he could always be counted on to illuminate a discussion by drawing on his stores of experience and by his shrewd criticism and ready wit. His good literary style is seen to advantage in the well-known work "Modern Foundry Practice," which he wrote in collaboration with Dr. Longmuir. Of fine presence and genial manner, he was a popular figure in the city of his adoption, and enjoyed the esteem and affection of his friends and colleagues, among whom were so many who owed to him a part of their metallurgical training.

We learn from the *British Medical Journal* of the death on March 26 of Dr. W. Ainslie Hollis at the great age of eighty-two years. Dr. Hollis was educated at Cambridge and St. Bartholomew's Hospital, receiving his M.D. in 1871. He was elected a Fellow of the Royal College of Physicians of London in 1876. Most of his life was spent at Brighton, where he set up in private practice; but his activities led him more to literary and scientific pursuits, during the course of which he made a fine collection of British macrolepidoptera. He was president of the Brighton and Sussex Medico-Chirurgical Society and of the Brighton Natural History and Philosophical Society, and in 1913 he served as president on the occasion of the Brighton meeting of the British Medical Association. Dr. Hollis was the author of numerous contributions to medical journals on disseminated fibrosis of the kidney, the duration of life in infective endocarditis, and other topics.

The death is announced, in his sixty-third year, of Dr. Henry Edgerton Chapin, who was professor of biology in Ohio University from 1891 to 1900. He then removed to New York to teach biology and physiography in the high schools there. He was the author of many scientific monographs, and collaborated in writing Chapin and Rettger's "Elementary Zoology and Guide."

We much regret to announce the death on April 21, in his seventy-third year, of Sir Alfred Bray Kempe, F.R.S., treasurer of the Royal Society from 1898 to 1919.

We regret to record the death on April 19, at seventy years of age, of Sir Alfred Pearce Gould, K.C.V.O., late vice-chancellor of the University of London, and president of the Medical Society of London and of the Röntgen Society.

Current Topics and Events.

At the meeting of the London Mathematical Society to be held on May 11, at 5 p.m., in the rooms of the Royal Astronomical Society, Burlington House, Prof. G. H. Hardy will deliver a lecture on "The Elements of the Analytic Theory of Numbers." Members of other scientific societies will be welcome.

The Institute of Physics, of which Sir J. J. Thomson is president, is arranging for the delivery of a course of public lectures with the view of indicating the growing importance and place which physics now holds in industry and manufacture. The first of these lectures was delivered by Prof. A. Barr of Glasgow, on Wednesday, April 26, in the Hall of the Institution of Civil Engineers.

Rai Bahadur Sarat Chandra Roy is carrying on with a considerable measure of success his new quarterly journal of anthropology, entitled *Man in India*. The third number contains two important articles by Mr. T. C. Hodson, the author of works on the Nagas and other Assamese tribes, on exogamy in India and free marriage, which merit the attention of anthropologists, besides shorter notes on the Kharwars and Khasis and on Indian palæoliths. The journal, which is published at Church Road, Ranchi, deserves encouragement.

A John Scott medal and certificate, with a premium of 160*l*., has been awarded by the Board of Directors of City Trusts, United States of America, to each of the following: Dr. William Duane, for "his researches in radio-activity and the physics of radium and of X-rays"; Prof. R. A. Fessenden, for "his invention of a reception scheme for continuous wave telegraphy and telephony"; Mr. Elwood Haynes, for "his discoveries in connection with stainless steel, stellite, chrome-iron, etc."; and Dr. T. B. Osborne, for "his researches on the constitution of the vegetable proteins."

The annual meeting of the Iron and Steel Institute will be held on May 4-5 at the house of the Institution of Civil Engineers. On the first day of the meeting, the new president, Mr. Francis Samuelson, will deliver his presidential address, and the Bessemer Medal will be presented to Prof. Kotaro Honda. The remainder of the meeting will be devoted to the discussion of some thirteen papers by various workers on the constitution, properties, and manufacture of iron and steel. The annual dinner of the Institute will be held on May 4 at 7.30 p.m. at the Connaught Rooms, Great Queen Street, W.C., and the autumn meeting will be held in London on September 5-7 next.

MR. JOHN PLACE, 16 The Avenue, Beckenham, Kent, directs our attention to a phenomenon known to the guides at the Solfatara of Pozzuoli near Naples, but not, as he believes, satisfactorily explained. When a lighted torch of brushwood or tarred string is introduced into, or merely waved near any of the crevices from which gases emanate, the emanation appears to be greatly increased and "smoke and steam issue from the spot where the torch is waved," and even from fissures at a considerable distance. We suggest that the burning of the torch provides nuclei for condensation of vapour; for clouds gathering in a volcanic crater have been traced, in some cases at least, to atmospheric vapour influenced by the fine ejecta from the vent.

THE issue of the index numbers of the physics and electrical engineering sections of *Science Abstracts* completes volume 24 of each. The physics section extends to more than 900 pages, 800 of which are occupied by 2000 abstracts, while the electrical engineering section of 650 pages devotes 600 pages to nearly 1200 abstracts. Both volumes are rather larger than pre-war issues, while the number of abstracts is approximately the same. The increase of length of the abstracts is scarcely justified by any increase in the intrinsic importance of the matter abstracted. The greater average length of the electrical engineering as compared with the physics abstracts is due mainly to the number of descriptions of power plants and installations. *Science Abstracts* continues to be one of the most valuable and time-saving publications issued in this country; without it, research in physics and electrical engineering would be seriously hampered and progress retarded.

THE issue of *Science* of March 31 contains an account of the opening of the Norman Bridge Physics Laboratory of the Californian Institute of Technology at Pasadena, South California. The laboratory and equipment have been provided by Dr. Norman Bridge with the object of furthering work of the highest type in the mathematical and physical sciences and their applications. In the opinion of Dr. Millikan no subject furnishes a better training in accurate observation, honest and dispassionate treatment of data, and logical deduction of consequences, while the classics are gradually disappearing as the foundation of the American educational system. The physics laboratory, of which Prof. Millikan has been appointed director, and the Gates Chemical Laboratory with Dr. Noyes as director, are to receive 7000*l*. per annum for five years from the Carnegie Corporation, and will thus be able to co-operate with the Mount Wilson Observatory in a joint investigation of the constitution of matter and the nature of radiation.

IN a paper read at a recent meeting of the Royal Colonial Institute, Mr. J. M'Whae, Agent-General for Victoria, dwelt on the importance of white settlement of the "heart of Australia," an area of over half a million square miles lying approximately within a circle of 400 miles radius, the circumference of which passes through Sydney, Melbourne, and Adelaide. This area at present contains only 3,300,000 inhabitants, although it comprises as great an area as France, Germany, Denmark, Switzerland, Holland, and Belgium together. He admitted, however, that the problem is not merely one of attracting population but depends also on the provision of a sufficiency of water. Artesian wells number over 5000, and there are in addition many shallow bores in the Riverina. In Victoria to-day 14,000,000 acres out of 56,000,000 acres are being artificially irrigated. The Murray river valley offers the greatest opportunities and considerable areas of arid land have been reclaimed. The greater part of the "heart of Australia" must, however, depend on artesian water, and to what extent this supply is inexhaustible remains to be seen.

THE annual report of the Smithsonian Institution of Washington for 1919 is a volume of nearly six hundred pages, of which the greater part is composed, as is customary, of noteworthy contributions to science which were made known during that year. In all, twenty-eight such publications are included. Sir Ernest Rutherford's article, "Radium and the Electron," which appeared in the Jubilee issue of NATURE of November 6, 1919, and Sir Arthur Keith's presidential address at the Bournemouth meeting to Section H (Anthropology) of the British Association on "The Differentiation of Mankind into Racial Types," from NATURE of November 13, 1919, are reprinted. There are also two translations, "On the Extinction of the Mammoth," by H. Neuville, which is taken from *L'Anthropologie* of July 1919, and "A Great Chemist: Sir William Ramsay," by Ch. Moureu, from *Revue Scientifique* of October 1919. Some of the remaining papers are reprinted from American journals and a few are original. The volume forms a valuable record of notable announcements in the world of science for the year 1919.

WE have received from Messrs. Harbutt's Plasticine, Ltd., of Bathampton, an inexpensive outfit for mounting insects and other natural history objects. The apparatus is very simple and consists of "thymo-plas," which is plasticine impregnated with a strong preservative, slides of celluloid, and binding strips of gummed paper. In using this method, a narrow strip of "thymo-plas" is used to form a cell of the desired shape on the centre of a celluloid slide: the object to be mounted is then transferred to the cavity thus formed and a second slide of celluloid is pressed down on top. The opposite ends of the two superposed slides are securely bound together with strips of gummed paper, and the mount is then complete. The paper strips also serve as labels upon which the necessary data relating to the specimen may be recorded. Any one who tries this method will find no difficulty in carrying it out; groups of insect eggs *in situ* on leaves or twigs, coccids, larval tubes, cocoons, pupæ, etc., can all be well exhibited when mounted in this way. The method can also be applied to samples of seeds, fibres, small shells, and many other objects. In so far as adult insects are con-

cerned the specimens are not so well displayed as when pinned and set, but, on the other hand, they are secure against damage, and the "thymo-plas" method should be valuable for teaching purposes when specimens must of necessity be handled frequently. Collections mounted in this manner can be stored in microscope slide cabinets with undivided trays. By way of advertisement it is stated that "thymo-plas" is "adopted by Prof. Lefroy as the standard method for use in the Entomological Department, Royal College of Science, London." The price of the outfit is 3*s.* and 6*s.* according to size.

Two catalogues of second-hand works of science, each of exceptional interest, have recently reached us, namely, Sotheran's Catalogue of Science and Technology, No. 3, and Heffer's Catalogue (No. 210) of Scientific Books and Publications of Learned Societies. In the former list many works from the libraries of the late Profs. Carey Foster, J. Perry, and P. Duhem are offered for sale. In the latter a prominent feature is sets of scientific journals. The catalogues are obtainable free of charge from their respective publishers—H. Sotheran and Co., 140 Strand, W.C.2, and W. Heffer and Sons, Ltd., Cambridge.

Our Astronomical Column.

THE APRIL METEORS, 1922.—Mr. W. F. Denning writes that what appears to have been the most brilliant and abundant shower of Lyrids observed during the present century was witnessed by Miss A. Grace Cook and Mr. J. P. M. Prentice, of Stowmarket, on the night following April 21. Miss Cook, watching the sky up to 13 hours G.M.T., observed 30 Lyrids, and a number of others must have escaped observation while the paths of the brighter meteors were being recorded. Eight of the meteors seen were brilliant, six of them being estimated as equivalent to, or surpassing, the lustre of Jupiter. The maximum of the display apparently occurred in the two hours preceding midnight; the meteors moved swiftly, leaving trails. The brightest object appeared at 11 h. 12 m. G.M.T., and it left a conspicuous streak which remained visible for twenty seconds. Mr. Prentice also watched the progress of the shower, and saw many brilliant meteors, though the sky was partly clouded at times.

At Bristol the sky was overcast during the whole night, and no meteors could be seen.

ECCENTRICITY OF DOUBLE-STAR ORBITS.—Prof. H. N. Russell shows (*Pop. Ast.*, March) that it is possible to deduce average eccentricities, by statistical methods, even in the case of those long-period systems in which only a very small portion of the orbit has been described. All that is necessary is to note the angle between the tangent and the radius-vector, and compare the observed distribution of angles with that resulting from different assumed values of eccentricity. From observations of 750 pairs he deduces a mean eccentricity slightly greater than 0·6, about the same as that given by stars the orbits of which have been determined. This is an important result from the cosmogonic point of view, as the orbits now considered must be very large, and the periods measured by millenniums.

PROGRESSIVE LATITUDE CHANGES.—The reported change of the latitude of the International Station at Ukiah, California, at the rate of a foot a year, recently attracted considerable notice. Prof. F. Schlesinger devotes an article to the subject in *Astr. Journ.*, 798. He notes that Cohn's proper motions (depending on the Auwers system) are used for the latitude stars at the International stations, and that they differ systematically from those of Boss. The following list shows the apparent annual change of latitude of the six stations—(1) using Cohn's system and (2) using Boss's: Mizusawa, Long. $-141°$ (1), $+0·0008''$ (2), $-0·0079''$; Tschardjui, Long. $-63°$ (1), $+0·0110''$ (2), $+0·0023''$; Carloforte, Long. $-8°$ (1), $+0·0053''$ (2), $-0·0034''$; Gaithersburg, Long. $+77°$ (1), $+0·0103''$ (2), $+0·0016''$; Cincinnati, Long. $+84°$ (1), $+0·0099''$ (2), $+0·0012''$; Ukiah, Long. $+123°$ (1), $+0·0106''$ (2), $+0·0019''$. It will be seen that the systematic northward shift resulting from Cohn's values vanishes when Boss's are used. If we ascribe the changes to a motion of the pole, the indicated motion is 5 inches per annum towards North America. We may, however, consider that at Mizusawa, which is in a volcanic region, there is an actual surface shift of 10 inches per annum southward; the shifts at the other stations are small enough to be regarded as accidental. Prof. Schlesinger urges that observations at the second, fourth, and fifth stations, which were dropped during the war, should be resumed, at least temporarily.

EFFECTIVE TEMPERATURES OF STARS.—Various methods used to obtain stellar temperatures give different results, yet it is interesting to note that the divergences are not great; indeed, for stars of classes G, K, and M, stars of comparatively low temperature, the agreement is fairly close. The cause of these disagreements lies probably in the fact that each observer has limited himself to a portion of the spectrum only, which may not necessarily contain the observed maximum spectral energy. Dr. W. W. Coblentz, in the Proceedings of the National Academy of Sciences (U.S.A.) (vol. 8, No. 3, p. 49), gives the results of his inquiry into the effective temperatures of 16 stars as estimated from the energy distribution in the complete spectrum.

By means of screens of red and yellow glass, quartz, and water he found it possible to obtain the radiation intensity in the spectrum in consecutive portions from $0·3\mu$ to 10μ. In addition to an interesting table giving a comparison of the total radiation from stars having closely the same visual magnitude but of very different spectral class, Dr. Coblentz sums up his results in another table, comparing his stellar temperatures with values previously obtained by other workers. As the values he has deduced will prove very useful for reference they are here reproduced, commencing with the hottest stars and passing through the various stellar types, taking class Go as standard.

Star.	Spectrum Type.	Temp.
ε Orionis	Bo	13,000° K
β Orionis	B8p	10,000
α Lyræ	Ao	8,000
α Can. Maj.	Ao	8,000
α Cygni	A2	9,000
α Aquilæ	A5	8,000
α Can. Min.	F5	6,000
α Aurigæ	Go	6,000
α Bootis	Ko	4,000
β Geminorum	Ko	5,500
α Tauri	K5	3,500
α Orionis	Ma	3,000
α Scorpii	Ma p	3,000
β Androm.	Ma	4,000
μ Geminorum	Ma	3,500
β Pegasi	Mb	3,000

Research Items.

THE DISPERSION OF FLIES BY FLIGHT.—A definite knowledge of this subject is of importance in measures of control or repression. It is also of significance in the study of the spread of fly-borne diseases. Messrs. Bishopp and Laake (*Journ. Agric. Research*, xxi. No. 10, Aug. 15, 1921) have conducted an extensive series of observations with several species of common flies, using an estimated total number of 234,000 specimens in the experiments. These were marked by being liberated into bags containing finely powdered red chalk or paint pigment, and afterwards allowed to escape. In order to ascertain the distance of dissemination, baited fly-traps were set at measured distances, in different directions, from the point of liberation. The experiments carried out show that under rural and urban conditions flies have marked powers of diffusion; similar results obtain for both the sexes, although in very different proportions in different species. The common house fly, *Musca domestica*, was recaptured at a distance of more than 13 miles from the point of liberation, *Chrysomya macellaria* 15 miles, and *Phormia regina* nearly 11 miles. The fact that many favourable feeding and breeding grounds were passed over by the flies appears to indicate that, in so far as the above three species are concerned, very evident migratory habits are noticeable. The authors conclude that, under natural conditions, the influence of moderate winds on dissemination is not of great importance. The speed of flight is evidently considerable; thus *Phormia regina* was recovered about 11 miles away in less than 48 hours after release, and *Musca domestica* travelled over 6 miles in less than 24 hours. The stimuli affecting dispersion appear to be so blended and mixed as to make it impossible to judge their relative importance.

THE ASCENT OF SAP.—Sir J. C. Bose informs us that he has carried out a series of investigations at the Bose Institute, Calcutta, which affords a complete explanation of the phenomenon of the ascent of sap, and its diverse manifestations. The following is a short summary of the results: (1) It is shown that the ascent of sap is a process of physiological activity dependent on the pulsation of living cells inasmuch as it is arrested by the action of poison, either in entire plants or in cut shoots. (2) The active pulsating cells are not confined to the root, but are continued throughout the stem. It has been ascertained that in the stem of Dicotyledons, these cells constitute the cortical layer which abuts upon the endodermis. (3) The velocity of the ascent has been determined by three independent methods, which give concordant results. The ascent takes place in plants even in the complete absence of transpiration. In "varnished" plants this velocity has been found sometimes to be as high as 70 metres per hour. (4) The cellular pulsations have been investigated and their characteristics determined from automatic records; they consist of alternate contractions and expansions. (5) The direction of propulsion is determined by the phase differences of the adjacent cells. The velocity increases with the wave length of the propagated impulse. This wave length is determined experimentally from definite points of electric maxima and minima. Enhancement of velocity is associated with corresponding increase in the wave length. (6) The enhanced rate of ascent is also attended by the increase of amplitude and frequency of cellular pulsations. (7) Ascent of sap depends upon cellular pulsation in tall trees as well as in herbaceous plants. There is, however, in the former the special adaptation of the woody tissue which serves as a reservoir to meet the excessive demand for water in the season of active transpiration. When this reservoir is more or less depleted, the phenomenon of "negative pressure" is manifested.

NORWEGIAN EXPLORATIONS IN SPITSBERGEN.—In 1917 the Norwegian Government decided to undertake the systematic survey and exploration of the western part of the mainland of Spitsbergen between Ice Fjord and the South Cape. This was in continuance of previous Norwegian work under the auspices of the Prince of Monaco on the west coast between the north of Spitsbergen and Ice Fjord. The work was to include geological exploration and hydrographical survey in coastal waters, where this was incomplete. In "Revue de Geographie Annuelle," Tome ix., Fascicules iv.-v., 1922, Mr. A. Hoel gives a full account of the surveys made in 1919, 1920, and 1921, when he was in charge, and a summary of the whole work, which is now virtually completed after five summers in the field. Only a few small gaps in the survey between Horn Sound and the South Cape remain to be filled in. Altogether some 4800 sq. kilometres of land surface have been surveyed. The most striking geological results are the proof of the Ordovician age of the Hecla Hook beds of the west coast, and the discovery that beds ranging from Carboniferous to Tertiary ages form the greater part of the coastal region south of Horn Sound where the Hecla Hook beds were supposed to predominate as they do farther north. The botanical researches, of which some important results have already been published, promise to be of great interest.

TERTIARY FOSSILS OF PERU.—We have received a copy of "Illustrations of the Tertiary Fossils of Peru," by H. Woods, T. Wayland Vaughan, and J. A. Cushman. It consists of twenty-four plates of fossils and their explanations, without any indication of the source of issue or the possibility of accompanying text. We understand, however, that they are intended to illustrate a forthcoming work on the "Geology of N.W. Peru," by Dr. T. O. Bosworth. The first twenty plates deal with Mollusca, and for these Mr. Woods is responsible, Mr. Vaughan answering for three of Corals, and Mr. Cushman for the one of Foraminifera. This separate issue will be very welcome to palæontological students, who will at once recognise the wonderful similarity of these Peruvian fossils to those of our British Oligocene and Eocene; indeed one, *Venericardia planicosta*, is said to be identical, while there is a Clavilithes, which the author, doubtless on good grounds, cites as a new species, but which one might be forgiven for mistaking for *C. longævus*. Mr. T. A. Brock, the draughtsman of the plates, is to be congratulated on his beautiful figures, which have been most admirably reproduced: we have seen nothing better.

RECORDS OF PALÆONTOLOGICAL RESEARCH.—It is well from time to time to emphasise the value of the simple paper-bound guides to the British Museum collections as means of keeping the student in touch with the developments of research. The tenth edition of "A Guide to the Fossil Reptiles, Amphibians, and Fishes" has just appeared, with 8 plates and 117 text-figures, price 2s. (1922). Here will be found the Downtonian ostracoderms of Lanarkshire, the problematic Palæospondylus, Ichthyosaurus from Lyme Regis, clothed in a habit drawn from German specimens, and Tritylodon, placed clearly with the theriodonts. One of the plates shows the immense proportions of the hind limb and tail of the Cetiosaurus discovered by A. L. Leeds near Peterborough.

The Limbs of Trilobites.—Those zoologists and palæontologists who have been fortunate enough to look through P. E. Raymond's recent monograph on the trilobites (see Nature, vol. 108, p. 481) will be glad to note Dr. C. D. Walcott's additions, comments, and suggestions as to limb-structure, in his recent paper on the Cambrian Neolenus (Smithsonian Misc. Coll., vol. 67, No. 7, 1921). The author proposes to put forward the results of further investigations into the organisation of trilobites "in the course of two or three years," so that our anticipations when directing attention to the stimulating nature of Raymond's paper were evidently correct.

Geology for Townsmen.—The Geological Survey of Great Britain has done great service to those who dwell or work in London by issuing a memoir by H. Dewey and C. C. A. Bromehead on "The Geology of South London" (Ordnance Survey, Southampton, 1921, price 3*s.* 6*d.*). This describes the country covered by the recent colour-printed map, showing superficial deposits, Sheet 270, on the scale of 1 : 63,360. Starting from the gravels of Ealing, Hyde Park, and Millwall on the north, we can realise, as in a series of pictures, the broad exposures of London clay south of the Thames, supporting at Wimbledon outliers of Glacial gravel; and in the south we reach the chalk at Sutton, and rise to the unspoiled uplands of Banstead Downs and Sanderstead. The geological colouring well marks out the old valley, widening quickly on the clay, by which the railways now reach Croydon from the south. The memoir contains a view of the area in 1794, looking across London from the north, and another of Richmond at about the same date. The sources of these should have been mentioned; they appear to be from separately published plates. A city and suburban map, of equal interest, but of a very different nature, is the Johannesburg Sheet (52) of the Geological Survey of South Africa. The scale is near 1 : 150,000. With the attached longitudinal section, it is an admirable exposition of the geological relations of the Witwatersrand system, and the moderate price of 5*s.* includes a memoir by C. T. Mellor and A. L. Du Toit (Pretoria, 1921). The area covers the whole historic mining district, and extends across the dolomite to the reappearance of the Rand rocks at Heidelberg.

Electrification of Phosphorus Smoke Nuclei.—With reference to a note on electrical precipitation which appeared in Nature of March 23, p. 388, we have received a paper by J. J. Dowling and C. J. Haughey (Proceedings of the Royal Irish Academy, vol. 36, Section A, No. 3) on the electrification of phosphorus smoke nuclei. The authors' experiments indicate that the nuclei in the smoke of phosphorus slowly oxidising in air acquire charges in an electric field, that the charges depend on the strength of the field, and that they vary in whole multiples of the electron. Charges from one to twenty-five electrons were observed. They also indicate that when large numbers of particles, of nearly equal sizes and charged equally, are exposed to the same electric field, the particles may be dragged through a comparatively narrow channel in the air, and may carry the air in this channel along with them. The mobilities of particles in fumes exposed to electric fields may, therefore, exceed considerably what might be expected for the limiting velocity according to Stokes's law applied to isolated particles (as in the well-known experiments of Millikan). This effect is obviously of importance in precipitation apparatus, and careful quantitative experiments of this kind should be of assistance in the design of such apparatus.

A New Science Microscope.—We have received from Mr. C. Baker of 244 High Holborn, W.C.1, an example of his new Science Microscope which has been specially designed to meet the requirements in science schools (Fig. 1). The stand is a single casting with a foot of the horse-shoe type but with a posterior limb which gives complete stability. A large square stage, 4·2 in. × 4·2 in. is provided with mirror below, with plain and concave surfaces. The coarse adjustment, of the diagonal rack and pinion type, gives a motion slow enough to enable the user to focus with comfort a $\frac{1}{6}$-in. objective—actually we found that even a $\frac{1}{12}$-in. objective could be used without difficulty. A combination 1 in. and $\frac{1}{6}$ in. objective was supplied and both powers were found to give excellent definition and flat field. The instrument is well finished, rigid in all parts and strongly built, and should prove a very serviceable one capable of withstanding rough usage. For the stand alone the price is 4*l.* 10*s.*, or with a No. 3 eyepiece and combination 1 in., $\frac{1}{2}$ in. and $\frac{1}{6}$ in. objective, 6*l.* 17*s.* 6*d.* In this particular instrument, the objective thread did not seem to be exactly the R.M.S. standard size, for we were unable satisfactorily to attach a Zeiss, a Leitz and four Swift lenses, which themselves were completely interchangeable on their respective instruments.

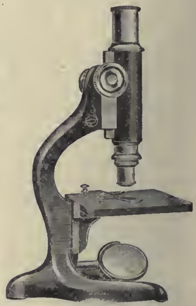

Fig. 1.

Thermometers for measuring Rock Temperatures.—An interesting new type of thermometer has recently been designed and constructed by Messrs. Negretti and Zambra, for the purpose of measuring the surface temperature of rocks, sand, or other materials. Since the difficulty in design lies in securing that the bulb shall take up accurately the temperature of the surface, whatever the other attendant circumstances may be, the new features of the instrument mentioned are associated with the bulb end of the thermometer. The other end of the thermometer is simply supported so that the stem, which is about 15 cm. long, lies parallel to the surface and about 0·5 cm. from it. At the bulb end the stem is curved so that the bulb (of rather larger size than in a clinical thermometer) lies along and almost touching the surface. Actual contact is effected by a thin flat copper plate lying on the surface and attached to the bulb, which itself is copper-plated on the outside. The under surface of the plate is roughened, and its relatively large surface (it is about 1 cm. wide) quickly takes up the temperature of the rock by conduction and radiation, and conducts the heat rapidly to the glass bulb. The upper surface of the plate, and the plated surface of the bulb, are polished to prevent radiation to or from the surrounding objects. The bulb is further insulated by a polished reflector which covers it almost entirely, and prevents radiation while also reducing conduction of heat by air currents. The reflector is gilt in order that it shall not become tarnished. The mass of the bulb is small, so that it possesses little thermal capacity and scarcely disturbs the condition of temperature existing before placing the bulb on the rock; the thermal inertia is also small for the same reason. The makers state that on holding the bulb near to the side of the radiator with the polished surface facing the radiator, the thermometer shows no change of reading, but on turning it round so that the flat copper plate faces the radiator, the column at once begins to move.

The Aryan Problem.

ON March 28, Mr. Harold Peake made a communication to the Royal Anthropological Institute on the subject of Bronze Swords and the Aryan Problem. He began by describing a type of sword, with a long tang cast to fit the hand, the Type II. of Naue, which is believed to have originated in the Danube basin. He showed how the butt of the blade had passed from a depressed semicircle through various forms to that of a flattened oval, and how its convex outline had then gradually become concave; he then divided the swords into a progressive series of seven types. He explained how the first of these had developed from a dagger, while the last had been found in the Hallstatt cemetery, where iron weapons had been the rule.

Mr. Peake next considered the distribution of the series, showing that type A was of Hungarian origin; type B ranged thence northwards to Denmark; type D was found in Greece and Egypt and in certain regions of Italy; type E ranged across France, England, and Ireland; type F was absent from Hungary and was confined to the mountain region of central Europe; while type G, the Hallstatt type, was also absent from the Hungarian plain but widely distributed to the west and north.

It was suggested that the Egyptian specimens were relics of the Ek-wesh, who invaded Egypt in 1220 B.C., and that those from Greece had been introduced by the Achæan invaders, who were, Mr. Peake thought, only a few wandering heroes, of Thraco-Phrygian origin, who made themselves masters of city states in Greece. This gave an approximate date to type D of 1250–1150 B.C., while type G could not be earlier than 1000–900 B.C.; he suggested that type A was evolved after 1400 B.C.

It was argued that the distribution of these swords must be referred rather to invasion than to trade, and it was suggested that peoples emerging from the Hungarian plain and adjoining mountain regions had passed thence, in 1350 to Denmark, in 1250 to Greece and Italy, and in 1150 to France and Britain.

Mr. Peake then discussed the absence of types F and G from Hungary, and showed evidence of the departure of some of these people through the Dukla pass, across Galicia and Podolia to the Koban. He showed how they learnt the use of iron from tribes on the southern slopes of the Caucasus and suggested their return to Hungary with their new weapons. Some of these invaded Greece as Dorians, while others pressed up the Save to the iron-fields and to Hallstatt for the salt-mines; they destroyed the lake-dwellings in the mountain zone, whence refugees fled down the Rhine to Holstein, to the east of England and to Ireland, while others passed through the Belfort gap into France and thence down the Rhone, Loire, and Seine. Other invaders crossed the Predel pass into Italy, destroyed the *terra-mara* culture of the Po Valley, and settled north of the Apennines near Bologna, introducing the Villanova culture, while others again passed by the old route into France, and followed the refugees down the Rhone and Loire but not down the Seine.

Thus there were two movements of peoples allied but in some ways distinct. The first waves had bronze swords and included the refugees from the lake-dwellings of the mountain zone; the second wave had iron swords and were the Dorians, Villanova, and Hallstatt peoples.

Turning to the linguistic side, Mr. Peake sketched in outline the Aryan hypothesis and referred to a paper published in 1891 by Sir John Rhys. In this paper it was suggested that two waves of similar people had dispersed from central Europe, westward and southward, the first speaking Q and the second P tongues. To the first belonged Gaelic, Erse, Latin, and Ionic Greek, to the second Welsh, Osco-Umbrian, and Greek. Sir John Rhys had suggested that the second wave consisted of non-Aryan people, probably from the Swiss lake-dwellings, who had learnt Aryan speech from their subjects.

Mr. Peake pointed out that Sir John's theory had not been well received, especially in Germany, and that certain of his conclusions could not be accepted. The Ionic dialect of Herodotus was not an archaic form, though perhaps Thraco-Phrygian might represent the Q form of Greek speech. Again, evidence was against the Swiss lake-dwellers being the conquering labialisers. Still archæology showed evidence of two dispersals, and it might be that Sir John's theory was correct in the main though erroneous in some of its details.

The case was tested in Italy, where Mr. Peake showed that the bronze swords were confined to a definite region, mainly around Fucino, while the Villanova culture centred chiefly north of the Apennines. He exhibited a map of the Latin or Q dialects, which coincided very nearly with the distribution of the bronze swords, except in one or two particulars, and to account for these he related a story told by Dionysius of Halicarnassus how the Aborigines dwelt in this area, but one night the Sabines, a P people, issuing from Amiternum, dislodged some of them, who eventually marched towards Rome and settled there.

Mr. Peake suggested that the Italian test seemed to prove that so far as this peninsula was concerned the archæological and philological evidences agreed. In Greece the first wave consisted of a few heroes only, the second wave was the only true invasion; here, as would be expected, we had only P speech. In France both waves covered the same ground, except that in the valley of the Seine the latter was lacking. It was in this valley that we had the best evidence of Q speech in Gaul, the river Sequana and the tribe Sequani. He maintained, therefore, that the equations all round were as clear as could be expected, and that the main features of Sir John Rhys' hypothesis were justified.

British swords for 25 years and that he agreed with

Mr. Parker Brewis said that he had been studying the typological scheme proposed by Mr. Peake. He was also prepared to accept the dates, though type G lasted in Britain to a much later date. Mr. E. C. R. Armstrong also agreed with the typology and chronology, but said that the philologists of Dublin would not accept the view that the Q people had ever settled in England.

After some remarks by Mr. Parkyn, Mr. Peake replied that his chronology referred to central Europe and not to Britain, and that he was well aware of the views of the Dublin philologists. He was prepared to admit, at any rate for the sake of argument, that there was no linguistic evidence for the early presence of Q people in England, but that such negative evidence was not conclusive in the light of the positive evidence he had adduced. At the request of the chairman, Dr. A. C. Haddon, he then outlined his views on the racial affinities of the people he had been discussing, and on the original dispersion of the Aryan people.

Woollen and Worsted Research.

THE annual report of the Council of the British Research Association for the Woollen and Worsted Industries for the year 1921 gives details of the progress which the Association is making, and includes some lines of its future activities. The Association is now in its fourth year, though it is only during the past year that its building and equipment have been sufficiently completed to furnish the research staff with reasonable facilities for extensive development of its work. The main activities of the Association during the year have resulted from the work of the research, education, and sheep-breeding committees of the Council of the Association, on which expert advisory members are co-opted.

As the publications of the Association are circulated to its members only, and to certain allied associations and institutions, it is difficult to estimate the actual extent of the work of the Association. One interim report has, however, been published dealing with faults caused by oils, effect of light on oil stains, photomicrographic work on raw wool, standard conditions for measuring wool fibre diameters, cross-sections of wool fibre, polarity of the worsted sliver, construction and control of the humidity room, and the effect of oil stains on dyeing. Two reports including observations on the elasticity and setting of wool by time, heat, and moisture, and work on the dyeing and burldyeing of union cloths have also been published. In view of its importance in the textile industry, it is surprising to find that the effect of light on the oils themselves does not appear to have been studied.

Reports are also in preparation on the fastness of dye-stuffs on woollen material, the sorption of neutral soap by wool and its bearing on scouring and milling processes, and on the methods of estimation and analysis of soap in cloth and yarn. In addition the research committee has sketched out a bold and comprehensive programme of research. The programme includes problems presenting themselves in most sections of the textile trade, and of its allied branches. The committee has obviously attempted to avoid "the short-sighted policy of confining research organisations to the search for results of immediate commercial value," and if results in some only of the branches named in the programme are forthcoming in future years, the Association should render help of the greatest value to the industry.

The education committee of the Association has been active in its efforts to co-ordinate textile educational work. As a result of a joint meeting with the Board of Education, the National Wool (and Allied) Textile Industrial Council, and the City and Guilds of London Institute, a Joint Advisory Education Committee has now been formed, which will assist the Board of Education and the City and Guilds of London Institute in textile educational matters. The education committee of the Association has itself drawn up syllabuses of textile courses, and has secured the provision of some research fellowships for textile work.

Coal Resources of South Africa.

UNDER the title "Recent Additions to our Knowledge of the South African Coalfields," Dr. E. T. Mellor has contributed a paper to the Transactions of the Geological Society of South Africa, vol. 25, which supplies a much-needed summary of the coal resources of South Africa.

The Witbank or Middleburg coalfield is the most important, and owing to the fact that it is comparatively readily accessible to the main line of the Transvaal-Delagoa Bay railway, it has been more extensively worked and more thoroughly prospected than any of the others. It is comparatively free from disturbances of any great importance, and the continuity of the seams has now been fairly well proved for a length of some 45 miles. There are five and in places six seams, the two most important being the No. 2 Seam, averaging 16 to 20 feet in thickness, and the No. 4 seam, averaging 24 feet, and in places reaching a thickness of 27 feet. All these coals are somewhat variable in character, there being some areas, fortunately quite extensive, in which the coal is of good quality with a relatively low ash, whilst in others the ash is much higher, owing, according to the author, to certain conditions that prevailed at the time of its deposition. In one block of 7000 acres, a tonnage of over 214 million tons has been proved, and the whole field is estimated as being capable of yielding at least 1000 million tons of coal of an evaporative power of 12·5 or over.

The Komatipoort coalfield has disappointed the expectations that were at one time formed of it and, in Dr. Mellor's words, "its prospects as a coalfield must be regarded as very doubtful."

In Swaziland recent boring operations have proved the existence of several seams, mostly thin, of coal of high quality, though the total tonnage likely to be developed does not at present appear to be very considerable.

In the Waterberg district several seams of good coal have recently been discovered, but owing to the distance from any line of railway, this field cannot be looked upon as of any value in the immediate future.

The Natal coalfield differs in many respects from that in the Witbank district; the coal seams are thinner, rarely exceeding 5 feet, and they have been broken up and greatly affected by intrusions of dolerite. Moreover, they lie relatively deep, and for these reasons are gassy and present greater working difficulties than the coal of the Transvaal field. The quality of the coal is good, but the prevailing impression as to the available quantity appears to be greatly exaggerated. It is now estimated that the best Natal coal is likely to be exhausted in another 40 or 50 years.

These statements show that the Witbank coalfield must be looked upon as the main source of South African coal supplies, and this field presents numerous advantages, amongst them being the shallowness of the seams and the ease with which they can be worked. South Africa may therefore be reasonably expected to become a formidable competitor in the world's coal markets, and to develop an important coal export trade. Coal is also likely to play an important part in the development of local industries, amongst which iron manufacture will probably be one of the most important. The main obstacles at present are the inadequacy of railway transport to the coast and the want of proper shipping facilities. It is obvious that both of these difficulties can easily be overcome, and when they are, South Africa will be ready to take full advantage of this additional source of wealth.

H. L.

A National Council for Mental Hygiene.

A GENERAL meeting will be held at 5 o'clock on Thursday, May 4, in the rooms of the Royal Society of Medicine, Wimpole Street, in order to decide on the constitution, officers, etc., of the new National Council for Mental Hygiene. The provisional committee consists of Sir Courtauld Thomson (chairman), Sir Norman Moore, Sir Charles Sherrington, Sir John Goodwin, Sir George Newman, Sir Walter Fletcher, Dr. C. H. Bond, Dr. Bedford Pierce, Prof. George Robertson, Dr. C. S. Myers, Dr. G. Ainsworth, Dr. Helen Boyle, Dr. Edwin Bramwell, Dr. Farquhar Buzzard, Sir Maurice Craig, Lord Dawson of Penn, Sir Horatio Donkin, Prof. Elliot Smith, Dr. Edwin Goodall, Dr. Henry Head, Dr. Crichton Miller, Sir Frederick Mott, Dr. W. H. R. Rivers, Sir Humphry Rolleston, Dr. T. A. Ross, Dr. Tredgold, and Dr. W. Worth.

A letter, signed by Sir Courtauld Thomson, appeared in the *Times* of March 29 which describes the purposes for which the new Council is being established. It will co-ordinate and encourage the work of the various existing societies which are "engaged in promoting the study of mental disorders, the welfare of the insane, the problems of industrial psychology and the various aspects of mental deficiency"; it will also aim at establishing psychological clinics in general hospitals for the early treatment of mental disturbance, and at improving the education of the medical student in normal and abnormal psychology. In addition, it will attempt to lessen the popular ignorance at present prevailing in regard to the nature and prevention of mental illness, which results in an enormous amount of needless unhappiness and wastage of energy.

Such National Councils have been and are being formed in various countries on the Continent, moulded largely according to the pattern of the well-known United States National Committee for Mental Hygiene, which has done so much to raise the standard of the care and treatment of mental disorders in America, and to remove the widespread prejudice of the public towards these diseases. In America it has given birth to smaller Societies for Mental Hygiene in the various States and to an important Canadian Committee. Ample work awaits the formation of a National Council in Great Britain, and we extend to it the cordial welcome which it merits.

University and Educational Intelligence.

CAMBRIDGE.—The Report of the Financial Board on the expenditure of the current academic year points out that, despite the Emergency Grant of 30,000*l*., the University depleted its balances by 3975*l*. during the past academic year; and it is anticipated that there will be a further deficit of 7650*l*. in the current year. The Report of the Royal Commission has not come any too soon unless Cambridge is to increase its fees or to cut down its activities.

Mr. H. G. Carter has been appointed Curator of the Herbarium.

The Linacre Lecture will be delivered on Saturday, May 6, at 5.15 P.M., by Sir Humphry Rolleston, on the subject of "Medical Aspects of Old Age."

LONDON.—The following are among the Public Lectures to be given at University College during the present term:—"Atoms, Molecules and Chemistry," three lectures by Sir J. J. Thomson; "Insects and Disease," four lectures by Sir Arthur Shipley; "Recent Discoveries in Egypt," by Prof. Flinders Petrie; and "The Expansion of European Civilisation," four lectures, by Prof. W. R. Shepherd, of Columbia University. A copy of the full programme may be obtained by sending a stamped addressed envelope to the Secretary, University College, London, W.C.1.

IT is announced by the Royal Academy of Belgium that a prize of 1000 francs has been established, which will be awarded biennially, under the name of the Prix O. van Ertborn, for the best work on geology.

PROF. E. MELLANBY will deliver the Oliver Sharpey lectures at the Royal College of Physicians of London on Tuesday, May 2, and Thursday, May 4, at 5 o'clock. The subject of the lectures will be "Some Common Defects of Diet and their Pathological Significance."

THE Ramsay Memorial Trustees will, at the end of June, consider applications for two Ramsay Memorial Fellowships for chemical research. One of the Fellowships will be limited to candidates educated in Glasgow. The value of the Fellowships will be 250*l*. per annum, to which may be added a grant for expenses not exceeding 50*l*. per annum. Full particulars as to the conditions of the award are obtainable from Dr. Walter W. Seton, Secretary, Ramsay Memorial Fellowships Trust, University College, London, W.C.1.

NEW regulations have recently been made by the Trustees of the Beit Memorial Fellowships for Medical Research. The date of the election of Fellows has been changed from December to July, so that Fellows may commence work on October 1, instead of January 1, in each year. In future there will be three classes of fellowships, namely, (1) junior fellowships, 350*l*. per annum. Not more than six junior fellowships will be awarded annually. The usual tenure of a junior fellowship is for three years. (2) Fourth-year fellowships, 400*l*. per annum. On the recommendation of the advisory board, a junior fellowship may be extended for a further period of one year. (3) Senior fellowships, 600*l*. per annum. A limited number of senior fellowships may be awarded. The usual tenure of a senior fellowship is for three years. No change will be made in the emolument of any fellowship held at the date of coming into force of these amended regulations on May 1, 1922. All correspondence of candidates and fellows should be addressed to the Hon. Secretary, Beit Memorial Fellowships, 35 Clarges Street, Piccadilly, W.1.

THE annual report for the session 1920–21 of University College, London, contains some interesting facts which may well be placed on record. The total number of students enrolled for full time courses was 2408, of which 1506 were men; in addition there were more than 700 attending part time courses. In the full time courses, arts and science claim about equal numbers. During the year, donations to the College amounted to a little more than 3000*l*., a total which includes sums of 1500*l*. from the Carnegie United Kingdom Trust for the school of librarianship; 500*l*. from the Worshipful Company of Drapers, an annual grant to the biometric laboratory which will continue until 1924; and a grant of 250*l*. from the Chadwick Trustees for the departments of municipal engineering and hygiene. The London County Council made a capital grant of 5000*l*. towards the cost of the completion and equipment of the department of engineering. As in past years, the College has taken an active share in the promotion of adult education by the provision of free public lectures by men of note. In all, some seventy lectures and courses were given and it is estimated that more than 8000 persons attended.

Calendar of Industrial Pioneers.

April 27, 1885. Joseph d'Aguilar Samuda died.—Entering into partnership with his brother Jacob, Samuda built marine engines, laid down railways worked on the atmospheric principle, and became an eminent builder of iron steamships and armoured men of war. In his works in the Isle of Dogs he introduced labour-saving machinery, and with Reed, Woolley, Scott Russell, and others he helped to found the Institution of Naval Architects.

April 27, 1891. Loftus Perkins died.—Known for his bold experiment of fitting the yacht *Anthracite* with an engine supplied with steam at 500 lbs. pressure, and for his invention of the "arktos" cold chamber refrigerating apparatus, Perkins was the son of the inventor Angier March Perkins, and the grandson of Jacob Perkins, who came to England from America in 1827 and in 1828 constructed what was probably the first triple compound steam engine.

April 28, 1865.—Sir Samuel Cunard died.—The founder in 1839 of the famous British and North American Royal Mail Steam Packet Company, Cunard was a native of Nova Scotia. His first transatlantic liners were built on the Clyde, while the first passage was made in 1840 by the *Britannia*, a wooden vessel of 1154 tons and 740 horse power, which took 14 days 8 hours to cross. Iron steamers were introduced in 1855, and the paddle wheel abandoned for the screw in the early 'sixties.

April 28, 1914. Robert Kaye Gray died.—After passing through University College, London, Gray became an assistant to Charles Bright, subsequently superintended the laying of many important submarine cables for foreign governments, and became the head of the Telegraph Works Company at Silvertown. He assisted in founding the National Physical Laboratory and served as President of the Institution of Electrical Engineers.

May 1, 1895. John Newton died.—Graduating from the United States Military Academy in 1842, Newton was employed on engineering duties and saw active service during the Civil War. He was afterwards responsible for the improvement of New York harbour, and during the removal of the notoriously dangerous rocks at Hell Gate solved many new problems.

May 2, 1857. Frederick Scott Archer died.—The discoverer of the collodion process in photography, Scott started life as a silversmith and then became a sculptor. It was while trying to obtain pictures of his work that he made his noteworthy discovery.

May 3, 1888. Sir Charles Tilston Bright died.—A most eminent telegraph engineer, Bright in 1847 at the age of fifteen, through Cooke, entered the Electric Telegraph Company, and in 1856 with Brett and Cyrus Field initiated the movement for an Atlantic Submarine Cable. Appointed engineer to the Atlantic Cable Company he was on board the U.S.S. *Niagara*, which jointly with H.M.S. *Agamemnon* laid the first cable from Valentia to Newfoundland, and in 1858 he was knighted. Bright afterwards carried out important cable work in the Mediterranean, in the Persian Gulf, and in the West Indies. One of the original members of the Institution of Electrical Engineers, he served as president of the society in 1886–87.

May 3, 1909. Thomas Aldridge Weston died.—The inventor of many things, Weston was known all the world over for his differential pulley block and lifting tackle, a simple contrivance of great usefulness. Born in Birmingham in 1832 he was for a time associated with the firm of Tangye, but his later years were spent with the Brown Hoisting Machinery Company of Cleveland, Ohio. He died in New York.

E. C. S.

Societies and Academies.

LONDON.

Optical Society, April 6.—Sir Frank Dyson, president, in the chair.—H. H. **Emsley** and E. F. **Fincham**: Diffraction haloes in normal and glaucomatous eyes. Every normal eye, under appropriate conditions, sees diffraction rings or haloes encircling bright sources of light. Similar haloes are seen by eyes in certain abnormal pathological conditions, particularly in the case of eyes suffering from glaucoma. Tests are specified by means of which the different phenomena in the two cases may be identified.—E. W. **Taylor**: The effect of changes of surface curvature at the focus of an astronomical object glass. The balancing of the components of a large object glass is difficult, and the effect at the focus of a similar alteration of curvature at each of the four surfaces is different. If the effect of an alteration at each surface is known, the one most suitable may be chosen, having regard to the nature of the aberration to be overcome.

PARIS.

Academy of Sciences, March 27.—M. Emile Bertin in the chair.—The president announced the death of M. Louis Ranvier, member of the section of Anatomy and Zoology.—E. **Goursat**: A classical theory of Cauchy. Comments on two recent communications by M. Mittag-Leffler.—H. **le Chatelier**: The manufacture of soda with ammonia. A discussion by a graphical method of the bearing of some experiments of M. Toporescu (see below) on the ammonia soda process.—C. **Richet**, Eudoxie **Bachrach**, and H. **Cardot**: Studies on the lactic fermentation. Memory in micro-organisms. Culture of the lactic bacillus is made for one day in a medium containing traces of three poisons (arsenate, cadmium, copper) and then seven successive daily inoculations are cultivated on normal media. The strain of organism thus produced is sensitive to the action of each poison. The authors conclude that when two cultures of micro-organisms of the same species have lived, even for a short time, in slightly different media, they are different from each other.—C. **Lallemand**: The parabolic wage. The system of wage payment described, which has been tested in practice over a period of 34 years, is based on a formula $S = S_0 + kT^2$, where S_0 is the minimum wage, T the work done, S the actual wage paid, and k a constant. It is in effect a compromise between payment by time and by results. It has been applied in the "Service du Nivellement général de la France" since 1888, with the result that while the wage increased in four years from 6·30 francs to 12·25 francs, the cost per kilometre decreased from 40 to 33 francs.—P. **Montel**: A theorem of algebra.—G. **Giraud**: Non-linear partial differential equations of the second order of elliptic type.—P. **Lévy**: The *rôle* of the law of Gauss in the theory of errors.—E. **Cartan**: Generalised conformal space and the optical universe.—A. **Planiol**: Study of the friction losses in internal combustion motors. Experiments were carried out on a specially constructed 30 H.P. gas engine by three methods differing in principle. The results showed that the resisting couple of the motor due to friction was a linear function of the mean pressure shown by the indicator diagram. The constants obtained were shown to apply to another (35 H.P.) gas engine, and hence it is found possible to calculate the field of an internal combustion engine without taking indicator diagrams.—H. **Roussilhe**: The applications

of aerial photography and the photo-restitution apparatus.—H. **Chaumat**: A new wattmeter.—O. **Liévin**: The kinetic study of alkaline solutions of iodine. In alkaline solutions, iodine is transformed into iodate by different reactions depending on the degree of alkalinity.—E. **Toporescu**: The preparation of sodium bicarbonate. An experimental study of the reaction $NaCl + NH_4HCO_3 = NaHCO_3 + NH_4Cl$. The solubilities of the salts at 15° C. were taken first singly, then in pairs, and finally omitting one constituent only. The results are plotted on the square diagram due to M. H. le Chatelier (see above).—A. **Mailhe**: The catalytic decomposition of oleic acid. The vapour of oleic acid passed over copper-aluminium pellets contained in a copper tube maintained at 600°-650° C. gives a gas rich in olefines (10 per cent.) and an acid liquid. The hydrocarbons, freed from acids, commenced to distil at 40° C. (amylene) and contained about 50 per cent. of olefines. These were removed by hydrogenation over nickel at 180°-200° C., and hexane, heptane, benzine, toluene, metaxylene, and nonane were identified in the resulting hydrocarbon mixture.—A. **Schoep**: Stasite, a new mineral, dimorphous with dewindite. This was obtained from a chalcolite from Kasolo (Katanga, Belgian Congo), and analyses led to the formula $4PbO \cdot 8UO_3 \cdot 3P_2O_5 \cdot 12H_2O$, which is identical with the composition of dewindite, from which, however, the new mineral differs in its density, colour, and the form of its crystals. Its radioactivity is a little less than that of dewindite.—L. **Blaringhem**: Abnormal heredity of the colour of the embryos of a variety of pea, *Pisum sativum*. Certain strains of pea, like hordeum and flax, present striking irregularities in the transmission of discontinuous characters.—H. **Ricome**: The elongation of roots.—M. **Molliard**: A new acid fermentation produced by *Sterigmatocystis nigra*. The products can be made to vary by changing the constituents of the culture fluid. If the nitrogen is deficient *d*-glucosic acid is the main acid produced; if the phosphates are reduced, then citric and oxalic acids preponderate.—J. **Pellegrin**: A new blind fish from the fresh waters of western Africa. This belongs to a new genus named Typhlosynbranchus by the author. The character of the branchial apparatus places it in the family of Synbranchus.—A. **Lécaillon**: The characters of a male hybrid arising from the union of a male duck (*Dafila acuta*) and female wild duck (*Anas Boschas*).—P. **Cristol**: Zinc and cancer. The proportions of zinc in various forms of cancerous tumours have been estimated. The preliminary results show that the high proportion of zinc found in cancerous tumours is a function of the proliferation and the cellular and nuclear activity.—J. **Mawas**: The limphoid tissue of the middle intestine of the Myxinoides and its morphological signification.—C. **Bourguignon**: The treatment of contraction by electrical stimulation of the non-contracted muscles in the lesions of the pyramidal bundle and in the secondary contraction of peripheral facial paralysis. Evolution of the chronaxy in the course of the treatment.—C. **Levaditi** and A. N. **Martin**: The preventive and curative action in syphilis of the acetyl derivative of oxyaminophenylarsinic acid (sodium salt). This salt has been shown to be stable, very soluble, rich in arsenic and relatively slightly toxic, and has been used with effect in the cure by injection of experimental syphilis of the rabbit. The present experiments deal with administration by the mouth and not by injection, and it was proved that this salt would cure experimental syphilis rapidly in the rabbit and the ape. Two cases in man were successfully cured in the same way, and its preventive action was also shown on the human subject.

Official Publications Received.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 51, July to December 1921. Pp. xii+289-462+13+27. (London: Royal Anthropological Institute.) 15s. net.

Transactions of the Geological Society of South Africa. Vol. 24: Containing the Papers read during 1921. Pp. iv+252+13 plates. (Johannesburg: Geological Society of South Africa.) 42s.

Madras Fisheries Department. Administration Report for the Year 1920-21. (Report No. 1 of 1922. Madras Fisheries Bulletin, Vol. 15.) Pp. 44. (Madras: Government Press.) 4 annas.

Proceedings of the Indian Association for the Cultivation of Science. Vol. 7, Parts 1 and 2. Pp. 59. (Calcutta.) 4 rupees; 6s.

The South African Journal of Science. Vol. 18, Nos. 1 and 2: Comprising the Report of the South African Association for the Advancement of Science, 1921, Durban. Pp. xxxviii + 200. (Johannesburg.) 15s.

Canada. Department of Mines: Mines Branch. Summary Report of Investigations made by the Mines Branch during the Calendar Year ending December 31, 1920. Pp. 87. (Ottawa: F. A. Acland.)

Reports of the Department of Conservation and Development, State of New Jersey. Annual Report for the Year ending June 30, 1921: Department of Conservation and Development, Administering Geology, Soils, Water Resources, Forestry, Forest Fire Service, State Museum, Testing Laboratory, State Parks, Land Registry. Pp. 105. (Trenton, N.J.)

Sudan Government. Wellcome Tropical Research Laboratories, Khartoum. Report of the Government Chemist for the Year 1921. (Chemical Section: Publication No. 22.) Pp. 38. (Khartoum.)

Jahrbuch der Geologischen Staatsanstalt. Jahrgang 1921, 71 Band. 1 und 2 Heft. Pp. 100. 3 und 4 Heft. Pp. vii+101-224. (Wien: Geologischen Staatsanstalt.)

Verhandlungen der Geologischen Staatsanstalt. Jahrgang 1921. Nr. 1 bis 12 (Schluss). (Wien: Geologischen Staatsanstalt.)

Diary of Societies.

FRIDAY, APRIL 28.

ZOOLOGICAL SOCIETY OF LONDON, at 4.—Anniversary Meeting.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—F. G. Royal-Dawson: The Need of an All-India Gauge Policy.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—T. Smith: The Position of Best Focus in the Presence of Spherical Aberration.—F. Twyman and J. Perry: The Determination of the Absolute Stress-variation of Refractive Index.—C. J. Smith: An Experimental Comparison of the Viscous Properties of (*a*) Carbon Dioxide and Nitrous Oxide, and (*b*) Nitrogen and Carbon Monoxide.—F. Twyman: Demonstration of the Optical Sonometer.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Museum Specimens illustrating the Forms of Inguinal Hernia.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—Sir Robert Jones: Presidential Address.

INSTITUTION OF AERONAUTICAL ENGINEERS (at Engineers' Club, Coventry Street, W.1), at 6.—Capt. Sayers: Some Unsettled Problems of Aeroplane Design.

INSTITUTE OF MARINE ENGINEERS, at 6.—Annual Meeting.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. E. G. Coker and Dr. K. C. Chakko: An Account of some Experiments on the Action of Cutting Tools.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—Capt. H. Whittaker: Some Notes on the Utilisation of Water Power.

ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. F. Dittmar: Outbreaks of Enteric Fever associated with Carrier Cases.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. A. Harden: Vitamin Problems.

MONDAY, MAY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—Annual Meeting.

INSTITUTE OF ACTUARIES, at 5.—E. H. Brown: The Valuation of Endowment Assurances by Select Tables.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Demonstration of Museum Specimens illustrating Sarcoma.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—Dr. C. V. Drysdale: The Testing of Small Electrical Plant.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Annual General Meeting.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.1), at 8.—Miss M. MacFarlane: Prof. Alexander's Theory of Values.

ROYAL SOCIETY OF ARTS, at 8.—F. F. Renwick: Modern Aspects of Photography (1) (Cobb Lectures).

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section), at 8.30.—Annual General Meeting.

TUESDAY, MAY 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire. Series II.: Racial Problems of Africa (2).

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. E. Mellanby: Some Common Defects of Diet and their Pathological Significance (Oliver Sharpey Lectures) (1).

INSTITUTION OF CIVIL ENGINEERS (Extra Meeting), at 6.—Sir John A. F. Aspinall: Some Post-War Problems of Transport (James Forrest Lecture).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.

WEDNESDAY, MAY 3.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—C. S. Franklin: Short Wave Directional Wireless.
SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—J. L. Lizius and N. Evers: Studies in the Titration of Acids and Bases.—C. Ainsworth Mitchell: Graphites and other Pencil Pigments.—Dr. J. C. Drummond: The Sulphuric Acid Reaction for Liver Oils and its Significance.—W. Singleton and H. Williams: Inadequacy of "A.R." Test for Alkalies in Calcium Carbonate.
ROYAL SOCIETY OF ARTS, at 8.—N. Heaton: The Production of Titanium Oxide, and its Use as a Paint Material.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.
INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Sir Ernest Rutherford: The Relation of the Elements (May Lecture).

THURSDAY, MAY 4.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 10.30 A.M.—F. Samuelson: Presidential Address.—F. Clements: British Siemens Furnace Practice.—D. E. Roberts: Notes on Blast Furnace Filling.—Prof. H. C. H. Carpenter and Miss C. F. Elam: Effect of Oxidising Gases at Low Pressures on Heated Iron.—C. R. Austin: Hydrogen Decarburisation of Carbon Steels, with Notes on Related Phenomena.—E. W. Ehn: Influence of Dissolved Oxides on Carburising and Hardening Qualities of Steel.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. H. Barton: A Syntonic Hypothesis of Colour Vision.
ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Dr. C. Shearer: The Heat Production and Oxidation Processes of the Echinoderm Egg during Fertilisation and Early Development.—Dr. H. Hartridge and R. A. Peters: Interfacial Tension and Hydrogen Ion Concentration.—W. Cramer, A. H. Drew, and J. C. Mottram: Blood-platelets and their Behaviour in "Vitamin A" Deficiency, and after "Radiation," and their Relation to Bacterial Infections.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. E. Mellanby: Some Common Defects of Diet and their Pathological Significance (Oliver Sharpey Lectures) (2).
LINNEAN SOCIETY OF LONDON, at 5.—Prof. Lloyd Williams: The Life-history of Laminaria and Chorda.
INSTITUTION OF LOCOMOTIVE ENGINEERS (at Engineers' Club, Coventry Street, W.1), at 7.15.—J. A. Hookham: Comparison between Superheated and Non-superheated Tank Engines.
CHEMICAL SOCIETY, at 8.—I. E. Balaban and F. L. Pyman: Bromo-derivatives of Glyoxaline.—E. P. Perman: The Properties of Ammonium Nitrate. Part IV. The Reciprocal Salt-pair $NH_4NO_3 + NaCl \rightleftarrows NH_4Cl + NaNO_3$.—Prof. E. C. C. Baly and H. M. Duncan: The Reactivity of Ammonia.—Prof. E. C. C. Baly, Prof. I. M. Heilbron, and D. P. Hudson: Photocatalysis. Part II. The Photosynthesis of Nitrogen Compounds from Nitrates and Carbon Dioxide.
CIVIC EDUCATION LEAGUE (at Belgravia Hotel, Grosvenor Gardens, S.W.1), at 8.15.—W. de la Mare: Character.

FRIDAY, MAY 5.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 10.30 A.M.—D. Selby-Bigge: Recent Developments in Power Production.—A. Westgren and G. Phragmen: X-ray Studies on the Crystal Structure of Steel.—N. T. Belaiew: The Inner Structure of the Pearlite Grain.—J. H. Whiteley: Formation of Globular Pearlite.—A. F. Hallimond: Delayed Crystallisation in the Carbon Steels: the Formation of Pearlite, Troostite, and Martensite.—K. Honda: The Constitutional Diagram of the Iron-Carbon System based on Recent Investigations.—K. Honda and T. Kikuta: The Stepped A1 Transformation in Carbon Steel during Rapid Cooling.—N. Yamada: The Heat of Transformation of Austenite to Martensite, and of Martensite to Pearlite.
ROYAL SOCIETY OF ARTS (Dominions and Colonies and Indian Sections), at 4.30.—Prof. W. H. Eccles: Imperial Wireless Communication.
ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Muséum Specimens illustrating Umbilical and Diaphragmatic Hernia.
INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—R. P. Howgrave-Graham: Electrically Oscillatory Discharges.
INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Failures.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. M. Grabham: Biological Studies in Madeira.

SATURDAY, MAY 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. D. H. MacGregor: Industrial Relationships (2). The Problem of Structure.

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

FRIDAY, APRIL 28.

BEDFORD COLLEGE, at 5.15.—Prof. E. Claparède: L'Intelligence et la Volonté (1). (In French.)
KING'S COLLEGE, at 5.50.—Dr. J. Hjort: Biological Aspects of Oceanography (1).

MONDAY, MAY 1.

BEDFORD COLLEGE, at 5.15.—Prof. E. Claparède: L'Intelligence et la Volonté (2). (In French.)
KING'S COLLEGE, at 5.30.—Dr. J. Hjort: Biological Aspects of Oceanography (2).

TUESDAY, MAY 2.

UNIVERSITY COLLEGE, at 5.—Sir Arthur Shipley: Insects and Disease (1).
BEDFORD COLLEGE, at 5.15.—Prof. E. Claparède: L'Intelligence et la Volonté (3). (In French.)
KING'S COLLEGE, at 5.30.—Dr. J. Hjort: Biological Aspects of Oceanography (3).—Prof. H. Wildon Carr: The Principle and Method of Hegel (1). The Real and the Rational.

WEDNESDAY, MAY 3.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. C. Winkler: The Human Neo-Cerebellum.
UNIVERSITY COLLEGE, at 5.15.—Dr. D. H. Scott: The Early History of the Land Flora (2).

THURSDAY, MAY 4.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Sir Archibald E. Garrod: More Inborn Errors of Metabolism.
ROYAL SOCIETY OF ARTS, at 5.15.—Sir Lawrence Weaver: Rural Re-Settlement and its Relation to Public Health (1) (Chadwick Lecture).

FRIDAY, MAY 5.

UNIVERSITY COLLEGE, at 5.—Prof. T. Borenius: The Re-discovery of the Primitives (Admission by Invitation only);—at 5.30.—Prof. W. R. Shepherd: The Expansion of European Civilisation (1).
KING'S COLLEGE, at 5.30.—Dr. J. Hjort: Biological Aspects of Oceanography (4).—R. F. Young: The University of Prague.

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NATURE

SATURDAY, MAY 6, 1922.

CONTENTS.

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Government Scientific Services.

IN a presidential address to the Washington Academy of Sciences[1] Mr. Alfred H. Brooks deals with the "Scientist in the Federal Service," and incidentally provokes comparison of Government scientific services in Britain and the States. The field to be covered, as he remarks, is continental in dimensions, and the needs of upwards of one hundred millions of people have to be met. So vast a proposition is beyond the powers of private enterprise and demands the systematised efforts of national bureaus. Washington, as the city of Government, formed the natural centre of Government research, and only during the last two decades became the home of other scientific institutions. In Paris, Berlin and London, science was fostered by old universities and learned societies, and it was only in researches for which co-operation on a large scale, and the maintenance of a permanent staff, were necessary, that the Government lent its aid.

The Federal scientific worker, we are told, giving his whole time to science, may tend to lose enthusiasm, and Mr. Brooks expresses a regret, with which we fully sympathise, that the non-professional man of science, with his enthusiasm and power to vivify science, is almost unknown in Washington and would fail to find there a congenial atmosphere. But in his fear that organised science leaves no place for the amateur and that competition with highly organised corps of professionals is impossible, surely he is unduly pessimistic. In Britain, at any rate, the amateur not infrequently leads the way and indicates the channels along which professional effort should be directed.

The Federal scientific service commenced about 1816. Now there are about forty institutions and upwards of 1500 investigators. At first the obtaining of funds depended largely upon the personality of the bureau chief. Pay was scanty, regulations were few, and appointments were made too largely under political influences. As practical applications of science increased, the bureaus were enlarged, and business methods were introduced, especially after 1906, as a result of the recommendations of the Keep Commission. Still more important was the realisation by the higher Government officials of the value of science in national economic problems. The demand for men began to exceed the supply, and whereas a bare living and a God-given love for his subject had been the scientific worker's only motives, the service became a profession for which the Universities graduated scores of highly trained specialists.

The tendency of a Federal service to collect facts without providing adequate interpretation, is inevitable. Organisation leads to uniformity, and, though a good

[1] *Journ. Washington Academy of Sciences*, vol. 12 (1922), pp. 73-115.

administrator may encourage individual effort in constructive thought, more consolation is found in the fact that the rare scientific genius cannot be suppressed, though there may be some danger of his applying his originality to financial and routine matters. Familiar indeed are the difficulties which scientific workers find in complying with the regulations controlling their expenditure, or accepting the limitations which a Treasury finds, or may think, necessary to place upon it. Regulations and limitations are regarded as personal insults, for the purpose only of hampering research.

The direction of a group of strongly individualistic investigators, including, it may be, a master mind, and almost certainly several hewers of wood and drawers of water, is no light task. Originality of thought has to be encouraged, but unity of purpose must be maintained in order to achieve the results demanded under the grant. The delinquents in such a group are usually unconscious of any delinquency, as for example the dilettante who flits from one problem to another and believes that he fulfils all obligations if he merely remains on the pay-roll; the brilliant mind that is so undisciplined that it cannot be made to formulate conclusions; or the hard-working procrastinator who dare not put forward his conclusions for fear of omitting some detail. Less deserving of sympathy are the pests who are as quick as a hair-trigger in publishing, and rush into print where more experienced men fear to tread, or the self-selected mouthpiece, who, unwilling to hide his light under a bushel, constitutes himself the agency by which science reaches the average man, and is too often taken at his own valuation. The "professional prominent scientist," another familiar type, at one time formed the popular authority in Washington. His dictum on any new problem was final, but he was more highly reputed by the public than by his colleagues.

A criticism passed on all men of science, not only by Mr. Brooks but also by literary men in Great Britain, relates to the form in which science is presented. The greatest need of the average American, and we may add of the British man of science, is to write clear English. He conveys his message to the people in language they cannot understand, and often he and his colleagues fail to understand one another. The development of such curiously similar types on the two sides of the Atlantic is interesting.

On the outbreak of war the Federal service proved its true worth. The bureaus formed the backbone of war service, for they were immediately available as storehouses of scientific facts and their great corps were quickly turned on to war problems. One result was to reveal the high commercial value of science, with the consequence that the ranks of the Federal service have been most seriously depleted. The best-trained men are now tempted away by the financial prospects of a commercial career, and the second choice only is left to the Government. It is suggested that the change may be due to the lowering of the ideals of the student, for the professor who is compelled to eke out a small salary by taking commercial work or writing text-books for profit, has not the same influence as a "revered master" in research. Without disparaging the high ideal attributed to the student, one is tempted to think that the possibilities of far higher emoluments in commercial service than could be justified in a Government bureau, are the principal inducement.

Pay, however, is not everything. Mr. Brooks reminds us that the young investigator who has obtained a post in the Government service, finds himself a member of a corps of well-trained enthusiastic professional men, whose actions earnestly express public duty and self-sacrifice. He will enjoy among them and in the non-professional societies congenial scientific companionship, and he will realise that the mere mass of such an army of investigators, whose ideals are not less lofty because they include the welfare of mankind, give an inspiration not excelled elsewhere.

A. S.

The Design of Electric Power Stations.

Power House Design. By Sir J. F. C. Snell. (Longmans' Electrical Engineering Series.) Second edition. Pp. xi + 535. (London: Longmans, Green and Co., 1921.) 42*s.* net.

THE second edition of this important work will be welcomed by all engineers who are interested in power-station design. The author is the chairman of the Electricity Commissioners; he has been both a distributing and a consulting engineer, and has therefore studied the problem from all points of view. The book is a storehouse of facts which will be of great value to the designer. The general principles which should be followed are laid down and illustrated by clear descriptions of many modern power stations. It is interesting to note that these stations are of very varied design. This is doubtless due partly to the individual experience of the designers, but it also bears out the author's contention that every case must be considered on its own merits, and so the solution applicable in one case may be unsuitable in another. The apparatus inside a power station should be standardised as much as possible, but at the present time it would be inadvisable to attempt to standardise the station itself.

The modern fashion is to concentrate generating

plant in large stations. This necessitates having a large supply of circulating water in the neighbourhood and it follows that capital stations are not necessarily situated near a pit's mouth. The most economical engines for driving dynamos are steam-turbines, provided they are worked at a very high vacuum, and in order to secure this we must have a supply of cold water equal to seventy times that required by the boilers. It is this consideration that rules out practically all the colliery sites in this country.

The author thinks that there should be at least two main generating stations to supply a large district. In addition he says that it generally would be found economical to generate part of the load at the points where the demand is greatest. It seems to us that the author does not lay sufficient stress on the fact that the cost of the network of cables required in a large distributing scheme may be 70 or 80 per cent. of the total cost of the undertaking. The main factor in determining the sites, therefore, will be the cost of the cables required. The cost of fuel transport and of the arrangements for circulating water may not vary much for different sites, but in general for a given supply the cost of the requisite cables will vary largely with the position of the power station. For commercial success it is very important that the capital cost of the cables should be as small as possible, and this can only be secured by a close study of the nature of the load required for industrial, domestic, and transport purposes, and then choosing the sites so that the cost of the cables is as small as possible. If the undertaking is to be a success, it is also necessary that the power-houses be capable of continual extension, so that the power available need never be much in excess of the demand. In the early days of the industry many of the stations built were much too large for the demand, and consequently years had to pass before they could pay dividends. It was difficult, therefore, to finance new schemes.

The following interesting comparison is made between the relative value of steam-engine and gas-engine plant. A boiler can easily evaporate 7·5 lb. of steam per lb. of coal consumed; a ton of coal will therefore yield 16,800 lb. of steam. A modern steam-turbine requires 8·2 lb. of steam per brake horse power hour developed. Hence a ton of coal will produce 2049 B.H.P. hours. With a gas producer operating on an average at a thermal efficiency of 75 per cent., a ton of coal of the same calorific value will yield power gas capable of producing 20,160,000 British thermal units. We may assume that on an average a modern gas-engine requires 9500 B.Th.U. per B.H.P. hour, and hence a ton of coal utilised in this way will produce 2122 B.H.P. hours. There is not much difference, therefore, in the amount of the mechanical energy obtained from the coal by the two methods.

It is pointed out that in certain cases an economy in fuel consumption can be obtained by using both steam and gas plant in the same station. The gas plant is almost immediately available, and so can be used to cope with any sudden temporary increases in the load, with consequent economies.

It has often been urged that it would be more economical to extract the potential by-products from the coal first of all and then utilise the resulting fuel products for power purposes. The author makes a careful examination of this procedure. He points out that serious thermal losses are involved in treating coal for by-product recovery and converting into coke or power gas or both. These losses range from 25 to 50 per cent. In the case of a power-house equipped with ammonia recovery producers for gasifying the whole of the coal, the total coal consumption would be from 70 to 80 per cent. greater than that of a corresponding coal-fired station. Considering it from the commercial point of view, he concludes that the prospects of obtaining through the medium of by-product recovery processes bulk supplies of electrical energy at a lower cost than coal firing are practically negligible.

Owing to the increasing attention devoted to the question of fuel conservation during the past twenty years, important developments in the utilisation of thermal products, which were formerly wasted on an enormous scale, have taken place. In particular, the surplus fuel gases produced at iron and steel works have been successfully utilised; for instance, at the important coke-oven works of Messrs. Pease and Partners, Durham, the waste heat is transformed into electrical energy by the supply company, and is "pumped" into the high-tension transmission mains for utilisation throughout the district.

The concluding chapter discusses hydro-electric power-houses, and important stations in America, Mexico, and Sweden are described. The attraction of cheap electric power has caused flourishing towns to spring up in the neighbourhood of some of the American waterfalls, but there are few cases where the hydro-electric power generated is transmitted to a considerable distance.

The author assumes that the reader is an engineer. The general reader, therefore, will occasionally have difficulty in understanding his nomenclature. The importance, for instance, of the load-factor of a station is emphasised, but even the engineer would appreciate being reminded that the load-factor is the ratio of the average load to the maximum possible load. The higher this factor, the more promising the com-

mercial outlook of the station. Later on the notion of the diversity-factor is introduced, defined as the ratio of the sum of the maximum loads on the separate substations to the maximum load at the power-house. It is generally assumed that the higher the diversity-factor, the load-factor remaining the same, the better it is from the commercial point of view. It seems to the writer that these definitions should be examined from a rigorous mathematical point of view to find how far their numerical values can be considered as trustworthy guides of the commercial practicability of a projected scheme.

A "silo" is generally considered to be a pit or cave for storing fodder in the green state. Engineers apparently call a coal-store a "silo," and that at the Greenwich power-house has a capacity of 2000 tons. The coal is fed from the bunkers, into which the silo is divided, into gravity bucket conveyors, which carry it to the overhead bunkers feeding the furnaces. The weight of the coal is checked on weigh-bridges with five-foot dials. It is stated that with a load of 5 tons the maximum inaccuracy is only about 3 lb.!

A. RUSSELL.

Witch-Craft in Western Europe.

The Witch-Cult in Western Europe: A Study in Anthropology. By M. A. Murray. Pp. 303. (Oxford: At the Clarendon Press, 1921.) 16*s.* net.

IN her study of witchcraft in Western Europe Miss Murray has endeavoured to show, first, that the witch-cult was a definite organised religion, and secondly, that it is possible to deduce from the records the character of its ritual. The problem which Miss Murray has set herself is entirely new and has not hitherto been considered, much less attacked.

As regards the evidence upon which Miss Murray's investigations are based, her aim has been to arrive at an impartial statement by quoting the *ipsissima verba* of the witches in their confessions and at their trials as recorded by contemporary chroniclers, all comments of those who compiled the records being omitted. Early accounts of witchcraft, as she points out, are apt to be vitiated by too great credulity or an excess of scepticism.

Exception is not infrequently taken to the evidence of the witches themselves on the ground that it was elicited under torture, but Miss Murray meets this objection by pointing out that in the English trials and in many of the Scottish trials legal torture was not employed. It is true that she is concerned principally with witchcraft in this country and deals with the French evidence only for purposes of elucidation and amplification; much of the French evidence was the result of torture, and even in this country in some of the most important cases torture was employed. In the case of the North Berwick witches, who were accused of a conspiracy against James VI. in which Bothwell was implicated, two were subjected to the ordeal of having their nails pulled out with pincers, pins were stuck into the quick, and they were tortured with the boot. It is to be noted, however, that the confessions, whether elicited under torture or without it, display a remarkable uniformity in detail, although drawn from a wide area and spread over a considerable period of time. This lends strong support to the view that the evidence may be accepted as it stands.

Taking the evidence at its face value, Miss Murray has arrived at the conclusion that the witch-cult was a definite organised religion and, as such, was a survival of the primitive religion of Western Europe. It represents, she holds, the religion of a pre-agricultural people who celebrated their religious festivals in accordance with a pre-solstitial calendar. She argues, reasonably enough, that the wholesale conversions to Christianity in the early days of tribes and peoples were merely superficial and that the bulk of the people continued to follow their old beliefs and to practise their traditional ritual, more or less in secret. If it be conceded that the witches in their accounts of what took place at the Sabbaths were describing, not furtive assemblies for malicious evil practices and unlimited debauchery, but gatherings for performing the rites of an organised religion, their evidence takes on an entirely new significance. Taking this point of view Miss Murray is able to deduce from it the character of the god they worshipped, the nature of the rites, and the organisation by which the religion was carried on.

The god, who was confused with the devil by Christians, was regarded by his worshippers as incarnate in man, woman, or animal. The animal form varied, being sometimes a bull, sometimes a dog, a cat, a horse, or a sheep. The goat, common in France, does not occur in this country. Further investigation of this point might throw light on the early history and distribution of the cult. The god incarnate acted as the leader of the association in which there was an inner circle or council, the "coven," consisting apparently of thirteen individuals. Miss Murray is of the opinion that in certain instances it is possible to identify these leaders, and cites, among others, Bothwell, Joan of Arc, and her companion in arms, Gilles de Rais, the French "Bluebeard." Her suggestion that the god was sacrificed at stated intervals would account for certain peculiar features in the trials, such as, possibly, the line taken by Joan of Arc under examination, and the

unsolicited confession of Major Weir, who was burned as a witch at Edinburgh in 1670. The evidence on this point would not be strong in itself, if it were not fully in keeping with Miss Murray's view of the witch-ritual. As is well known the central features of the Sabbath were a feast and sexual licence. This suggests inevitably that it was a fertility rite of the type familiar to anthropologists. It was only at a later date, and in the first instance by popular perversion that the function of the witch became the blasting of crops and herds as set forth in the famous Bull of Innocent VIII.

Many other topics are discussed in this important study which are of the greatest interest to anthropologists, and it bristles with points which call for further consideration did space allow. It has, however, one aspect to which reference must be made, and that is its bearing upon mediæval history. From this point of view it is a book which no historian or student can afford to neglect. The position of the Church and its relation to witchcraft before the beginning of the fifteenth century must be reconsidered first in the light of Miss Murray's conclusions and, secondly, with reference to the numerical strength the cult could command as an organisation—a point upon which Miss Murray does not touch.

The Riddle of Bird Migration.

Die Rätzel des Vogelzuges. Ihre Lösung auf experimentellem Wege durch Aeronautik, Aviatik und Vogelberingung. Von F. von Lucanus. Pp. viii + 226. (Langensalza: H. Beyer und Söhne (Beyer und Mann), 1922.) 30 marks.

THE migration of birds remains one of the most tangled problems, as it is one of the greatest marvels of the zoologist's world. In the old days known facts were few and hypotheses were correspondingly simple (and as a rule erroneous), but with multiplicity of data, theories, guesses and suggestions have so increased in number and complexity that they form in themselves a new problem for the seeker after truth. In the matter of precision of data the present generation holds a great advantage over its predecessors.

The institution of bird-ringing in Denmark by Mortensen in 1899, and its subsequent development in Germany by Thienemann and others, and in this country by the University of Aberdeen and Mr. Witherby, raised hopes of an early solution of many difficulties; while the development of air-craft and of their use in bird-watching, in which von Lucanus himself was a pioneer, has led to information which appeared once to be beyond man's grasp.

In the light of the results of these new methods, von Lucanus restates the problems of the origin and causes of migration, of its direction, height and speed, of its meteorological relations, and, most subtle of all, of the pathfinding of the birds, and re-examines the solutions which have been suggested. It may be said at once that there are here many new facts, and that in many respects the work of the former generation of observers has been superseded; but with it all, the reader is left with the feeling that while precision has been gained in problems of observation, the great problems of interpretation remain still beyond ken. Time after time the author is driven back for explanation upon an incomprehensible "migratory instinct" or "impulse" (Zugtrieb). Thus, having rejected, on account of their inadequacy as imminent causes of autumn migration, the fall of temperature, the shortening of the day, the lack of food, the changed atmospheric conditions due to the passing of the summer solstice, he concludes, "a bird departs as soon as the time for its departure has come and the migratory impulse has been awakened, without requiring any particular external stimulus.' Or again, having found tradition, warmer zones, anticyclonic conditions, wind guidance, a supposed magnetic sense, power of vision, each and all insufficient to account for the orientation of a bird's migratory flights, he says, "on its journey a bird requires no particular guidance, but follows an instinct which decides the direction automatically."

Von Lucanus has long been recognised as the champion of migration at comparatively low levels in the air, as against the idea of high-level migration which Gätke made popular. Many observations by airmen have been added to his early balloon observations, and he still regards the general height of migration to be under 400 metres, and flight at 1000 metres or over to be exceptional. Many records support his view, but conflicting evidence involves us in difficulties, for the author makes no mention of the observations of such of our airmen as Capt. Collingwood Ingram, who saw a flock of five hundred geese or ducks at about 11,500 feet, cranes (possibly) at 15,000 feet, birds resembling linnets at 10,000 feet, sandpipers at 12,000 feet, and so on. (*Ibis*, 1919, p. 321-5.)

The riddle of migration is not solved, but this volume, rich in observations and analyses, gives an excellent synopsis of the present state of knowledge, and points the way for future research. We may express the hope that the German bird-watching stations, disorganised owing to post-war conditions in Germany, may soon be able to resume their activities and add to the vast contributions they have already made to a fascinating study.

J. Ritchie.

Modern Chemistry.

Traité de Chimie Générale. Par Prof. W. Nernst. 2e édition française, complètement refondue d'après la 10e édition allemande par Prof. A. Corvisy. Première Partie: *Propriétés Générales des Corps—Atome et Molécule.* Pp. viii+620. (Paris: J. Hermann, 1922.) 30 francs net.

PROF. NERNST'S monumental treatise on general chemistry is so well known in this country and in America that no commendation of it is needed. It is a standard work in Germany, where it has already gone through numerous editions. In its French dress it has established a position in other parts of Europe and in Latin America. The volume under review—a large octavo of more than 600 pages—is the first part of the second French edition; it has been thoroughly revised in conformity with the latest German edition. It deals with the general properties of matter and with atomic and molecular theories in the light of contemporary knowledge. In effect it is a treatise on the application of the fundamental principles of modern physics to chemistry, with due regard to inquiries wherever the study of chemical physics is actively pursued. Indeed, the wealth of bibliographical reference is one of the most commendable features of the work. This, of course, is as it should be. Science knows no national boundaries. This was not always so recognised in Germany. In times not so very remote it was not unusual to notice a tendency to make the world believe that the study and development of physical science, and particularly chemistry and physics, had become almost the exclusive function and prerogative of German professors. Instances were not unknown of actual appropriation of other men's work or of the wilful suppression of all mention of their labours. No such charge could possibly be brought against the author of this work. He apparently keeps his eyes open to all sources of knowledge and welcomes evidence from any quarter.

Although the general plan of the work is unchanged, the alterations and additions in the present French edition are very considerable. Many of the paragraphs have been greatly modified, and in some cases wholly rewritten; others have been added; some of the less important have been shortened and even discarded, so as to keep the book within bounds. Theoretical conceptions and new developments which found no mention in the first edition, such as the quantum theory, the constitution of the atom, the new thermodynamical theorem, the theory of relativity, atomic numbers, equations of state, the molecular theory of the solid state, the frequency of atomic vibrations, the elucidation of crystal structure by X-rays, radioactivity, isotopism, etc., now find their appropriate place and are dealt with at due length. The book is eminently readable, and the mathematical treatment in no wise deterrent. Prof. Nernst's excellence as an expositor has in no sense suffered by the clarity and precision of Prof. Corvisy's rendering. The book is remarkably free from typographical errors, although, as might be expected in a volume of its size, a few mistakes occur here and there. It will be news to many readers that a Lord Rayleigh developed a certain formula relating to gaseous mixtures so far back as 1587.

Text-books of Elementary Mathematics.

(1) *Elementary Calculus.* By Prof. William F. Osgood. Pp. ix+224. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1921.) 12*s.* 6*d.* net.

(2) *Calculus for Beginners: A Text-book for Schools and Evening Classes.* By H. Sydney Jones. Pp. ix+300. (London: Macmillan and Co., Ltd., 1921.) 6*s.*

(3) *A First Course in the Calculus.* Part 2, *Trigonometric and Logarithmic Functions of x, etc.* By Prof. William P. Milne and G. J. B. Westcott. (Bell's Mathematical Series for Schools and Colleges.) Pp. xv+181-402+xv-xxxix. (With answers.) (London: G. Bell and Sons, Ltd., 1920.) 5*s.*

(4) *Exponentials Made Easy, or The Story of "Epsilon."* By M. E. J. Gheury de Bray. Pp. x+253. (London: Macmillan and Co., Ltd., 1921.) 4*s.* 6*d.* net.

(5) *Mathematics for Technical Students: Junior Course.* By S. N. Forrest. Pp. viii+260. (With answers.) (London: Edward Arnold, 1920.) 7*s.* 6*d.* net.

(6) *Elementary Algebra.* Part 2. By C. V. Durell and R. M. Wright. (With answers.) (Cambridge Mathematical Series.) Pp. xxiii+253-551+xlvii-lxxxv. (London: G. Bell and Sons, Ltd., 1921.) 5*s.* 6*d.* net.

(7) *A Concise Geometry.* By Clement V. Durell. (Cambridge Mathematical Series.) Pp. viii+319. (London: G. Bell and Sons, Ltd., 1920.) 5*s.* net.

(8) *Co-ordinate Geometry (Plane and Solid) for Beginners.* By R. C. Fawdry. (Bell's Mathematical Series for Schools and Colleges.) Pp. viii+215. (London: G. Bell and Sons, Ltd., 1921.) 5*s.*

(9) *Elements of Practical Geometry: A Two Years' Course for Day and Evening Technical Students.* By P. W. Scott. Pp. v+185. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 5*s.* net.

(1) PROF. OSGOOD'S "Elementary Calculus" supplies a need—the need of the young mathematician for a sound introduction to the differ-

ential calculus. The treatment is almost without blemish and is so simple and clear that the beginner should have no serious difficulty. Chaps. 1-4 introduce only algebraic functions; chaps. 5-8 are concerned with trigonometric and exponential functions and the corresponding inverse functions. The treatment of infinitesimals and differentials in chap. 5 is specially to be commended. The author has one or two hobby-horses. One that he ought not to have ridden here is the denial of the existence of "infinity." He says (p. 27): "We should not read 'Z approaches infinity,' . . . but 'Z becomes infinite'; . . . the statement sometimes made that 'Z becomes greater than any assignable quantity' is absurd. There is no quantity greater than any assignable quantity." This last remark contains a certain misunderstanding, and, in any case, such subtleties are not suited to beginners. Among minor points it is curious to note that there is no definition of a limit in the book. Some proof, or at least a reference, should be given for the proposition quoted on p. 113: "A convex curved line is less than a convex broken line which envelops it and has the same extremities."

(2) It is a pity that authors who do not "make reference to difficulties which seldom arise in the minds of elementary students" generally manage to make their subject so uninteresting. We do not ask for proofs. Mr. Sydney Jones effectually suppresses such an unreasonable desire by putting the word "proofs" in inverted commas in his preface. But could we not have a little colour? Let us take MacLaurin's theorem as a sample (p. 158). Mr. Jones says: "Assuming that a function $f(x)$ can be expanded in positive integral ascending powers of x . . . .

$$f(x) \equiv A_0 + A_1x + A_2x^2/1.2 + \ . \ . \ . \ ,$$

to determine the coefficients A_0, A_1, A_2, . . ." He then differentiates the series and determines the coefficients, as if this were a most ordinary and most dull proceeding. His pupils no doubt wonder vaguely, learn their lesson by rote, and pass on. If he would only pause to tell them what a wonderful theorem this is, or point out how great are the assumptions he is making, it would be well worth the space. Judging the book from the author's own point of view, there is little to find fault with in it. But he should not call a differential coefficient a "differential" (p. 18, etc.).

(3) This misuse of the word "differential" is a bad habit that appears to be gaining ground. The authors of "A First Course in the Calculus" are also addicted to it (preface and p. 215). Their text-book is mainly manipulative; it contains the usual treatment of the infinitesimal calculus, and concludes with a chapter on differential equations. The proof, depending on the area of a circular sector, for the limit of sin θ/θ (p. 181), is open to the objection that students are generally taught to use the limit in question for finding this area. It is not necessary to use a formula for an area at all (see, for example, Levett and Davison's "Plane Trigonometry," p. 82). Many mathematicians would be pained by the author's statement on p. 343: "If we proceed indefinitely, taking only a fractional part of a given object, it is perfectly plain that the fractional portion will soon be very small indeed." There is no doubt that an intelligent person can convince himself that the limit of x^n is zero, if x is less than unity, but a more exacting logician demands a proof of the proposition. The authors hope that "the student will have nothing to unlearn if he afterwards . . . proceeds to a rigorous course of modern analysis." But it would be a pity if he learnt to regard analysis as the proving of the "perfectly plain."

(4) Mr. Gheury de Bray calls his book a "little brother" of "Calculus Made Easy." We do not know whether the late Prof. S. P. Thompson would have been pleased with this facetious little relative. The only portion of the work that we can unreservedly recommend is a long preliminary quotation from Henri Fabre (pp. 1-12). There follow part 1 on indices, binomial series, etc., and part 2 on the exponential series, the equiangular spiral, the hyperbola (because its area is a logarithmic function), the catenary, the parabola (because it resembles a catenary), the probability curve, and "exponential analysis." The method consists in "talking round" the subject; something may be said for it, but it requires skilful handling, and in this author's hands it is often long-winded and obscure. The unwary should be warned that the method, which is stated on p. 55, is not "mathematical induction," but a kind of sampling; the statement on p. 147 that the centroid of a catenary arc is its middle point is, of course, incorrect. The last chapter is interesting, but too difficult for any one who would care to read the rest of the book. In sum the author had an excellent idea, which he has not quite managed to realise.

(5) "Mathematics for Technical Students" is designed for the first two years' work following on an elementary school course. The treatment is apt to be rather too formal in places—Mr. Forrest teaches algebra in the old style like a game of patience with x's and y's for playing cards, and only hints that algebra has something to do with the workaday world after his pupil has learnt to play the game. The treatment is, of course, still quite defensible, but it is now generally thought better to reverse this order

with technical students, who are only too apt to regard mathematics as a game instead of an essential part of their business. The book is, for the rest, well proportioned and quite suitable for its purpose.

(6) The subject known as "Elementary Algebra" has been so metamorphosed in the past ten or twenty years that its name ought to be changed. Graphs, differentiation, integration, and nomography are not algebra as understood by Salmon, Chrystal, or Weber. A little trigonometry and as much geometry as is required should be added and the whole called elementary mathematics. The breaking down of the watertight compartments into which school mathematics used to be divided is a development in the right direction.

The scheme of this book is interesting. The bookwork is only given in outline in the text or hinted at in the introduction. It remains for the teacher to fill in this framework according to his own lights. And then the text-book gives him examples that are both numerous and apposite. The scheme has much to recommend it, and will be welcomed by teachers who are accustomed to do their work thoroughly. The authors need not apologise for introducing a chapter on nomography, although this chapter will be found difficult without a much fuller treatment.

(7) It is a melancholy fact that examinations dominate and thereby spoil much of the education that they are intended to test and encourage. A considerable part of the education in this country has no higher purpose than the passing of a public examination at some future date. Mr. Durell, who is capable of much better things, says quite frankly that he has compiled a cram book, and we can recommend it for that purpose. The range is roughly that of the Cambridge schedule.

(8) The syllabuses for the Army entrance examinations and those conducted by the Oxford and Cambridge Joint Board have been assimilated, in the hope that Army classes at public schools may thereby be discontinued. This is a little unfortunate for Mr. Fawdry, whose "Co-ordinate Geometry" is written for Army candidates. But the book should prove quite suitable for the general classes into which the Army classes may be merged. Mr. Fawdry has the humanity to insert one or two historical notes (pp. 29 and 75). They are slight, but it is wonderful how much interest they add to the reading. We should like to see more of them.

(9) One of the difficulties of the teacher of modern elementary geometry is the devising of life-like examples. He will solve this difficulty if he gets Mr. Scott's text-book on practical geometry. The text-book is meant for young draughtsmen, and is full of such things as draughtsmen have to draw. The only general criticism we would make is that, while Mr. Scott gives clear instructions, he never justifies them, and we cannot believe that rule of thumb is a good rule even for draughtsmen. Chap. 8, about which the author is a little apologetic, is rather out of place. It contains some methods of constructing a "true length," when plan and elevation are given. The chapter is good in itself, but it stands at a different level from the rest of the book. The subject should be either left out or treated more fully. Standing alone, it will not be understood by the majority of readers.

H. B. H.

Studies in Symbiosis.[1]

Tier und Pflanze in intrazellularer Symbiose. By Prof. P. Buchner. Pp. xi + 462 + Tafel 2. (Berlin: Gebrüder Borntraeger, 1921.) 114 mk.

THE third section of Dr. Buchner's book deals with the highly controversial thesis that symbiotic bacteria are the cause of luminosity in many insects and marine animals. In this discussion, the author's critical faculty is at fault. He does not set out clearly the opposing lines of evidence nor does he do full justice to the work of Dubois, the protagonist of the "enzyme-theory" of animal luminosity.

Briefly, the issue is between the enzyme and the bacterial modes of light production. According to Dubois and Newton Harvey (whose work was reviewed in NATURE, October 6, p. 174), luminous animals contain two substances, one of which, when oxidised in the presence of the other, gives rise to light of an extremely "efficient" kind. The firefly's light is the standard—the most efficient light known, so far as the amount of light in relation to the expenditure of energy is concerned. One of these substances is a heat-stable, dialysable, oxidisable light producer, the other is not heat-stable, is non-dialysable, and is apparently a proteid. These substances are obtained by "dissolving" whole animals or their phosphorescent mucus in water or alcohol and precipitating with ammonium sulphate. No attempts appear to have been made to test the solutions for the presence of bacteria. An aqueous emulsion boiled in 20 per cent. hydrochloric acid for three hours retains the power of producing light when added to a cold-water emulsion. In the former the heat-stable "luciferin" has been separated from the unstable catalyst "luciferase," while both are present in the cold-water extract. The presence of the activator is necessary for light

[1] Continued from p. 539.

production which in that case accompanies the rapid oxidation of luciferin; otherwise the process occurs without the evolution of light. The cold-water extract glows for a time until its luciferin is completely oxidised, and it may be made reluminescent by adding some of the hot-water extract.

The bacterial theory of animal light, though possibly consistent with the enzymic one, is based on entirely different data. In its modern form, as an explanation of the phosphorescence of fireflies, glow-worms, and such marine animals as Pyrosoma and certain cuttle-fish, it is due to Italian zoologists, and especially to the work of Pierantoni. Dr. Buchner is a convert to this view and is a worker in this field. He gives a very interesting account of the evidence, which is of a biological, and not, as in the case of the enzyme school, of a chemical character. According to these observations, the luminous organs of cephalopods, be they never so complicated, are essentially cultures of bacteria in media suitable for their nutrition, and in situations favourable for obtaining oxygen.

In the common Sepia, for example, the organ (hitherto called the accessory nidamental gland and regarded as part of the egg-producing mechanism) consists of a modified part of the mantle within which different kinds of bacteria occur. Some are luminous, others are not. They also occur in the egg membrane before development, and Pierantoni describes the infection of the embryo by bacteria derived from those of the egg capsule. In a similar manner he explains the relationship between the luminosity of the egg of the glow-worm and that of the larva and adult beetle. The cells of the luminous organ of Pyrosoma contain structures that are also apparently symbiotic organisms. Noctiluca, however, has not yet been examined from this point of view.

The difficulty that many will feel in regard to this or the rival solution of an admittedly complex problem is the incompleteness of the explanation hitherto given of flash and occultation and of the apparent transmission of a mechanical stimulus from one part of a luminous animal (as in Pyrosoma) to another, lighting the "lamps" as it travels along. The solution seems to lie in the phases and disturbances not only of respiration, but of other controlling factors leading to continuous or alternating evolution of light.

Dr. Buchner has performed a signal service by collating much of what is known of intracellular symbiosis in animals, and his book is one that is most suggestive for further experiment and observation. It indicates the fruitfulness of border-line investigation, and should be widely known amongst biologists to whatever section of organic science they may belong.

F. W. GAMBLE.

Our Bookshelf.

Industrial and Power Alcohol. By Dr. R. C. Farmer. (Pitman's Technical Primer Series.) Pp. x+110. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2s. 6d. net.

THE author has certainly contrived to include a very large amount of information regarding alcohol in this little book, which contains clear descriptions of the properties of the alcohols and the methods of production. There are interesting chapters on the technical applications and the use of alcohol for the development of power. By no means the least informative part of the book is the numerous references to government regulations and restrictions. Thus, after a statement of some of these restrictions, we read on page 31:—"Plant is stereotyped, and there is no encouragement to introduce improvements in method or in apparatus. Transport by tank is forbidden, and no distillery is permitted to be more than a quarter of a mile from a market town, whereas it would frequently be better to situate the distillery near to the raw materials." We can commend this book to any who are interested in the development of alcohol as a fuel.

Les Combustibles liquides et leurs Applications. Par le Syndicat d'Applications Industrielles des Combustibles liquides. Pp. iii+621. (Paris: Gauthier-Villars et Cie, 1921.)

ONE may liken this volume to the many similar pocket-book issues extant in this country as compendious guides to the various branches of applied science. It serves a double purpose as an epitome of petroleum technology and as a standard work of reference for immediate requirements in the field, refinery, and office, and although written essentially for the use of the French industries concerned with inflammable liquids, it deserves a much wider sphere of utility. This type of publication, though frequently condemned as inimical to the best interests of scientific work and commercial production, commands a degree of popularity for which it is not, perhaps, difficult to account.

H. B. MILNER.

The Development of Institutions under Irrigation; With Special Reference to Early Utah Conditions. By Prof. G. Thomas. (The Rural Science Series.) xi+293. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1920.) 16s. net.

PROF. THOMAS aims at tracing the evolution of water legislation in Utah from 1847, when the Mormon pioneers founded Salt Lake City, to the present time. He shows how the Mormons, if not the first people in America to practise irrigation, were certainly the first to establish it on an extensive scale, the whole of their civilisation practically resting on this type of agriculture. They showed the way to reclaim vast areas of arid land and on their pioneer attempts have been based the methods utilised in other parts of the United States. He also traces the influence of this type of agriculture on the plan and design of the cities of Utah. The book would have been improved by the addition of a map.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Buoyancy of the Sun-fish.

ABOUT the end of August numbers of sun-fish (*Orthagoriscus mola*) make their appearance off the north coast of Ireland floating passively on the surface of the sea. The positive buoyancy, while not so great as to prevent the fish from submerging when attacked, constitutes a constant upward drag which brings it back to the surface as soon as it stops swimming. So far as we know, the bodies of all other fish have a specific gravity greater than that of sea-water, and the swim-bladder, where it exists, contains the necessary amount of gas to compensate for this and bring the body of the fish to neutral buoyancy.

The sun-fish has no swim-bladder, and on cutting up a fish and throwing pieces of the various organs overboard, it was found that everything sank except the liver and the skin. The liver floats no doubt because of the large quantity of fat it contains. The skin is 2-2½ inches thick and, the fish being flat, forms a large proportion of the body: it is evident that the fish floats passively on account of this buoyant jacket.

The skin is made of a tough elastic material, slimy to the touch, resembling rather soft cartilage: as a whole it is stiff enough to form what may be described as a rigid coat. For more detailed examination a number of slices were preserved in sea-water formalin: the slices had not changed in their appearance or proportions, and this pickled material probably represents fairly the fresh condition apart from such features as the solubility of the mucus, etc. The epidermis is 1-2 mm. thick; internally the skin is bounded by the very thin parietal peritoneum: the rest is uniform in appearance and shows microscopically a felted mass of thin wavy fibres arising stellately from connective tissue cells. There are a few rather thicker straight fibres but nothing of the nature of trabeculæ or struts. A few canals—presumably mucous ducts—are found here and there. No stainable fat is present, nor can any be obtained from dried material by extraction with ether, chloroform, or petrol.

After washing out the salt in distilled water, the specific gravity of the substance of the skin was found to be 1013 to 1016 with a mean of 1014 by weighing in air and water and floating bits in salt solutions of different strengths. It is difficult to get very precise results since one has to start with pieces in the rather indefinite state of being "surface dry." The specific gravity of pieces soaked in 0·9 per cent. NaCl solution was 1021. This may be taken to be somewhat near the natural gravity since it is known that the concentration of the body fluids of teleostean fish corresponds with that of mammals and is much less than sea-water. Taking the gravity of sea-water as 1026, these figures are compatible with the observation that the whole fish is just buoyant.

The most remarkable thing is that the percentage of solids in the skin washed out in distilled water is only about 3·7 per cent., figures varying from 3·5 to 4·2 being given by different pieces while the loss of weight on drying *in vacuo* over sulphuric acid is practically the same as the loss in an oven at 95° C. Histologically the larger part of the skin substance appears to be made of connective tissue fibres, and it is extraordinary that 2 per cent. or less of the mucoid material can give, when it is swollen with water, a tissue the mechanical firmness and rigidity of the skin.

The specific gravity of the dried solids, by floating in chloroform-petrol mixtures, was 1·335. Calculation from this gives a specific gravity of 1010 or thereabouts for the undried material. The difference between this and the determined value of 1014 (involving a value of about 1·6 for the solids) may be an error of observation or indicative of a condensation of the mucoid material when it is swollen in water, such as is known to occur with starch, gelatine, and proteids (Chick and Martin, *Biochemical Journal*, vii. (1913), 92).

After formalin fixation, the mucus is not soluble in dilute sodium carbonate, and once the skin has been dried *in vacuo* it will not swell up again in water, dilute acid or alkali.

G. C. C. DAMANT.
A. E. BOYCOTT.

Thursford, East Cowes.

Haloes and Earth History.

IN continuation of my letter on this subject in NATURE of April 22, p. 517, fifty additional measurements of the small Ytterby haloes have been made. The same consistency among the readings is noticeable. The mean result is a radius of 0·0052 mm. Introducing two corrections not previously applied (for the somewhat higher stopping power of this mica and for the fact that in such measurements we do not generally deal with the extreme range) I find that the range in air might be as much as 1·4 or even 1·5 cm. The nuclear correction would reduce this a very little.

The consistency of measurements among these haloes is, I think, even greater than would be found to obtain among normal haloes. The law prevailing among halo-dimensions is only apparent upon comparison and classification. It is by no means *prima facie* evident. It was just for this reason that it for so long escaped notice.

There is evidence that some of the larger sized Ytterby haloes deserve consideration as constituting a true radioactive development. Their radius is consistently 0·0086 mm. The nucleus is far too small to account for the difference. With all allowances (save that for the nucleus) this comes out as 2·4 cms. in air at 15° C. This is suggestively like that of UI (2·50). But we seem debarred from the tempting conclusion that hibernium may be a proto-uranium by the time-difficulties involved.

The paragraph in my letter referring to the possibility that the Ytterby haloes might date back to a prior geological era requires some explanatory amendment. It would be better to speak of the Archean as what (as I believe) it really is—the record of a past geological era; a material record finally brought to an end by thermal changes sufficient to evaporate the oceans. The reading of the halo—could we read it aright—would then assign a date to the formation of the containing mica. Upon the *prima facie* evidence this date is very remote. That is all I have to say upon this point.

There are, as I have intimated, possible alternatives to the view that very great time intervals are involved. The element responsible may emit α-rays the connection of the range of which with the radioactive

constant may involve a very different constant from that which, with small modification, applies to the three known radioactive families. Still more fundamental would be the discovery of some other than a radioactive origin for these haloes. I have considered many alternatives. One naturally thinks of a chemical influence emanating from the nucleus. Apart from the difficulty of accounting for the consistent measurements, the existence of bleached haloes in this mica, which possess the characteristic dimensions of uranium and emanation haloes, seems a formidable difficulty. The relation between the radioactive staining and the bleaching is everywhere such as to suggest that the latter is a modification of the former. A quantitative difficulty also exists. The volume of the nucleus varies from the $\frac{1}{5000}$ to the $\frac{1}{15000}$ part of the halo-volume which it has affected. Yet the nucleus may be a limpid particle revealing no trace of loss or decomposition. Only radioactivity can confer on one atom the energy requisite to ionise many hundreds.

Of course some one of the known elements may be responsible for these haloes. Geiger and Nutall long ago pointed out the difficulty which would attend the discovery of radioactivity in elements having a radioactive constant proportional to such ranges. But here we have an integration such as far transcends the resources of the laboratory. Until this point is settled—if it ever will be possible to settle it—a distinguishing name seems desirable. To this name the addition of numerals would suffice to deal with such halo-developments as may be ascertainable.

J. JOLY.

Trinity College, Dublin, April 25.

Pythagoras's Theorem as a Repeating Pattern.

THE interesting communication from Major MacMahon on the above subject reminds me of a proof which I discovered over the chessboard a few years ago, of the well-known fact, that if the lengths of the sides of a right-angled triangle are 3 and 4, the length of the hypotenuse will be 5.

Placing pawns at A, B, and C (Fig. 1), we require to prove that A is equidistant from B and C. We put

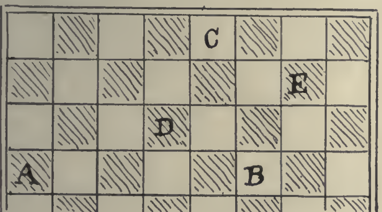

FIG. 1.

two more pawns at D and E, when it will be readily seen, even by a person unacquainted with Euclid, that A, D, E are in line and that CEBD is a square. Since any point on a diagonal of a square must, by symmetry, be equidistant from the extremities of the other diagonal, AB = AC.

The corresponding general proof of Pythagoras's theorem is as follows. Given $x^2+y^2=z^2$, we get

$$\frac{z+x-y}{x+y-z}=\frac{x+y+z}{z+y-x}. \qquad (1)$$

by algebra. Taking horizontal and vertical axes of reference through an origin O (Fig. 2), we mark down a point A the co-ordinates of which are $\frac{1}{2}(z+x-y)$, $\frac{1}{2}(x+y-z)$, and a point B the co-ordinates of which are $\frac{1}{2}(x+y+z)$, $\frac{1}{2}(z+y-x)$. By the given relation (1) OAB is a straight line. Through A and B draw ordinates PQ, SR, each equal to PS, and in the square PQRS inscribe the square ADBC by marking off RD = PC = SB. Then, drawing the ordinate DN, we have

$$DN = PS = \tfrac{1}{2}(x+y+z) - \tfrac{1}{2}(z+x-y) = y,$$
$$ON = OP + PA = \tfrac{1}{2}(z+x-y) + \tfrac{1}{2}(x+y-z) = x,$$
$$OD = OC = OP + SB = \tfrac{1}{2}(z+x-y) + \tfrac{1}{2}(z+y-x) = z,$$

which proves the theorem.

It is to be noted that in any special case where x, y, z are given integers (as in the case given above), it can be easily shown that OAB is a straight line

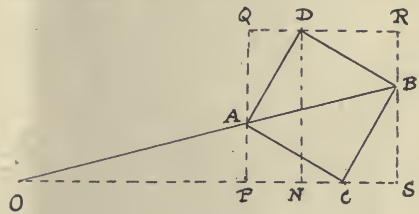

FIG. 2.

without knowing anything about proportion. Thus in such cases Pythagoras's theorem is proved without introducing areas. It has, I believe, been suggested that the ancient Egyptians must have been acquainted with Pythagoras's theorem, since they knew that a triangle with sides 3, 4, 5, is right-angled. But they may possibly have known only the special proof here given.

Lastly, it may be noticed that Euclid's axiom about parallels is tacitly assumed when we allow that a repeated pattern of squares can be constructed.

J. R. COTTER.

Trinity College, Dublin, April 15.

Man.

MAN is a social animal through habit, not instinct. Religions, morals, taboos, customs, conventions, which he learns through imitation, supply him with rules of thought and conduct. Without them human society could not exist. But there are two sorts of rules. The one kind binds the body, limits action, supplies rules of conduct, and impels men to "play the game" fairly. The other sort binds the mind, limits thought, impels men never to question the rules. *When the rules that bind the mind are many and strait, men tend to regard lightly the rules that bind to conduct.* All this may seem far-fetched, but consider universal history. Is it not the fact that communities have been inefficient, stagnant, and turbulent in proportion as their minds have been bound?

I may be afflicted with racial prejudice, but to me it seems that the men of English speech owe their predominant position in the world to the fact that they more than others "play the game" scrupulously, and yet have been freest of all in their thoughts, and so, while obeying their existing rules, have most readily altered the rules both of conduct and of thought. We English may have only one sauce, but, fortunately, we have a hundred heresies. Modern English history tells of continuous evolution, but of only one revolution. Compare the histories of more orthodox countries. Men cannot get away from habit, and mental habits depend not so much on the things that are learned as on the way in which they are learned. Through imitation we get emotional convictions and closed habits of mind; through curiosity, intellectual convictions and open, reflective habits of mind. When a man is mentally "too old at forty" his mind has been artificially closed. It can no longer profit from experience.

He has become unintelligent. Consider the unlike results which would follow the teaching of science on the grounds of faith and of evidence. In the former case there would be stagnation, passionate and unending controversy, with deference to this authority and hatred of that; in the latter case, contempt for mere authority, efficiency, progress, cool discussion, and ultimate agreement. Always it is not so much the thing that is taught that matters, but the way in which it is taught, through imitation or through curiosity. Consider how inefficient were such nations as Russia and Turkey in the late war, and how they are smashed beyond repair. Had the peoples of the world been less prejudiced and more intelligent there would have been no war. The subject is immense, and desire for compression has made me didactic; but readers of NATURE may fill lacunæ, and perhaps forgive my manner.

Men learn, through imitation, unlike standards. Among us are people who regret the Dark Ages: as before them there were doubtless those who regretted the manly times of Saxon piracy, and before them those who grieved for painted savagery. But, obviously, if we desire intelligence, efficiency, a contented and prosperous population, and a progressive civilisation, we must teach our youth as much as possible through evidence. We cannot help imparting some things through imitation (*e.g.* our ideas of right and wrong), but our special aim should be to create through curiosity an open, reflective habit of mind. This is, of course, the way in which science has been created, and which its workers constantly advocate. But it is vain to express mere opinions. Many people who professedly, indeed sincerely, seek the same ends think it primarily essential to close the mind to evil by teaching especially the emotional convictions they may happen to hold, and to expend the rest of the pupil's time by causing him to learn through labour other things (*e.g.* languages) which are commonly acquired through imitation. A man may learn all the languages in the world and yet not part from a single prejudice.

Fortunately, the history of society furnishes crucial examples in abundance. For example, the modern world, like the Græco-Roman, but unlike every other, has been prolific in men great in thought or action. In these two worlds men have learned especially through curiosity. With very rare exceptions, only Christians (who more than others have abandoned mere imitation) have produced great men; and among Christians great men have been almost limited to the less orthodox (*i.e.* less imitative) sects, or to defaulters from the more orthodox. Consider Newton, Darwin, Napoleon and his contemporaries, Garibaldi, Bismarck, and the rest. The crime-rate of modern communities, ranging from civil war and rebellion, through brigandage and murder, to acts of petty violence, is immensely higher among the more orthodox, who, both peoples and individuals, usually occupy inferior positions and attribute their misfortunes to oppressors, native or foreign. But emigration to other lands leaves such people unchanged, as witness the alien population of Great Britain and the United States, with its emotionalism, tendency to corruption, and high crime-rate. Government by the orthodox is invariably corrupt or inefficient, or both, as in Russia, Turkey, and medieval England.

Efficient modern Governments, hoping to obtain peace, are often pathetically anxious to confer self-government on the orthodox. But you cannot make a silk purse out of a sow's ear. As object-lessons, compare Russia and Germany in defeat. The latter, wrecked by an emotional despot and his Byzantine Court, is cleverly reconstructing her prosperity. Russia was, and is, and will long continue, an autocracy or lapse into chaos. People with the degree of intelligence permitted by the Orthodox Church could not possibly evolve a free and orderly State. Consider all the nations of the world. Invariably you will find that the men whose rules limit thought are inferior to those whose rules, relatively speaking, limit only action. Many empires have perished in the past from internal decay or external pressure. In the former case the decay has always coincided with an increase of training through imitation; in the latter, rival nations have increased their training through curiosity. We may confer self-government on populations in India, Egypt, and nearer home; but very certainly these populations will then only reproduce societies like those which people similarly trained have produced elsewhere.

Science has endowed humanity with a vast command over Nature, but has been less successful in establishing the scientific spirit. Within the limits created by his prejudices, facts may be taught to the adult, but frames of mind, as a rule, only to the very young; and science has neglected to consider the education of the latter. It is one thing to discover the shape and age of the earth or the origin of species, and quite another thing to persuade men already biassed to accept the intellectual consequences. It is one thing to invent explosives and aeroplanes, and quite another thing to make men, already made creatures of emotion through imitation, tolerant, reflective, open-minded, rational, so that discovery shall not be used for evil. The world is seething with passionate hatreds, the offspring of prejudices, which are derived from imitation. Consider the moral and religious differences which are indelibly impressed on the minds of children, and are the root-causes of nearly all the trouble that ferments from Galway to Singapore. Knowledge, the child of Science, has outgrown her twin Wisdom, and in the hands of violent and intolerant men may easily bring our civilisation to ruin. Consider ancient Rome and how exactly her decline coincided with the rise of fanaticism. Compare, as revealed in their literatures, the minds of the fervid saints with those of the common-sense pagans. But at least we may try to guard our own land. We have a unique opportunity; for among the British, the least prejudiced of moderns, are many who would accept crucial evidence concerning the development of society if it were offered fearlessly and insistently, and only the followers of science can so offer it. The main difficulty lies in the beginning: it will be hard to move scientific men, especially biologists, to action. From the nature of their training they lack enthusiasm (which is an emotion), and therefore organisation, and therefore power. Compare Salvationists. The little finger of General Booth is thicker than the loins of the president of the Royal Society. But probably, were the movement in favour of a right method of mental training well started, the laity would supply the enthusiasm. However, all that is on the knees of the gods.

I now conclude my letters to NATURE. They may, perhaps, have achieved some small success in things about which I care little, but probably none at all in the things about which I care much. I think they have been misunderstood. I am not wildly concerned about biological terminology *per se*, or about chromosomes, or whether groups of naturalists limit their facts to those furnished by zoology and botany, or experiment, or biometry, and so forth, or whether they bring a wider range of evidence from other sciences and studies into court by means of crucial testing. If the public be uninterested or stupid, it matters not how biologists divert themselves. If it be interested and intelligent, it matters supremely; but

in the latter case biologists will be compelled, by pressure from outside, especially from the followers of other sciences, to adopt the right methods, whatever they may be. But I am concerned with mind and education, and the moment one tries to reach bed-rock in such matters one finds oneself in biological quicksands. One is told that some characters are innate and some acquired, but not the distinction between the innate and the acquired. It is understood that things that are learned are acquired, but apparently no one has tried to ascertain how much is learned or how it is learned. Seemingly, all biologists are agreed that, in themselves, acquired characters are trifling things; but while Lamarckians think them important through their cumulative effects, neo-Darwinians, conceiving them as transient, think them unworthy of study. Both parties mean one thing when they apply the word "inherit" to "innate" characters, and the exact opposite when they apply it to "acquirements."

Man is the educable animal, say some biologists. He is not educable, say (in effect) others who declare that in his mental make-up nature is four, perhaps nine, times more potent than nurture. One admires the precision of statement, but wonders what is meant. As I understand it, man's nature is such that he is particularly responsive to the nurture of mental use. It is as if a physicist had stated that the steam is four, perhaps nine, times more potent than the engine. And so on. Meanwhile, prejudice controls education and society flows towards the cataracts. I may be very ignorant as to facts and mistaken in my opinions, but in that case my demolition should be a holiday task to the trained and learned intellect. Failing demolition, I cannot help believing that biologists do not realise how very great their science is, or might be, and how vitally and immediately important their labours are, or should be. Incidentally, I have sought in these letters of mine to indicate the high importance, as it appears to me, of classifying characters, not as innate and acquired, but, as physiologists do, according to the stimuli which cause them to develop. So far as I am able to judge, unless scientific men ascertain precisely how mental characters are developed, and then vigorously apply their knowledge for the betterment of education, modern society will soon be on the rocks.

G. ARCHDALL REID.

9 Victoria Road South, Southsea, Hants.

Configurations of Molecules of Benzenoid Substances.

PROF. ROBINSON'S remarks (NATURE, April 15, p. 476) on Sir William Bragg's representation of the naphthalene molecule, as it occurs in crystals, lead me to invite attention to results obtained recently by Mr. G. H. Christie and myself. In a paper which will be published in the forthcoming number of the Journal of the Chemical Society, the resolution of *trans*-6 : 6′-dinitro-diphenic acid into optically active components is described. This, with the fact that an apparently homogeneous brucine salt has been obtained from the *cis*-form of the acid, indicates that in the separate molecules (as distinguished from their crystalline aggregates, to which Sir William Bragg's results apply) of these compounds the two benzene nuclei are not coplanar.

If this be so, it follows that the direction of the valency of each of the carbon atoms through which these nuclei are united is not, as represented in the usual formulæ for benzene, exerted in the plane of the benzene ring, and further, that this condition is a stable one rather than a phase of an oscillation of the type referred to by Prof. Robinson. It may be possible to determine to what extent, if at all, this stability involves a modification of the normal benzenoid properties associated with two benzene nuclei. Differences between diphenyl itself and benzene in respect of their molecular refraction, and behaviour on catalytic reduction and towards ozone, are already on record, so that it will also be pertinent to inquire whether the fixity of configuration is a general property of diphenyl derivatives, or is dependent on the nature of the substituents present, and connected, for example, with the observations of Baly and Collie (Trans. Chem. Soc., 1905, 1339) on the modification of the ultra-violet absorption of benzene by the introduction of a nitro group.

In any case, our result would appear to supply the first direct experimental proof that other configurations of the separate benzene molecule may exist than the plane (Kekulé) type. For the great majority of chemists, who also recognise the merits of the Kekulé formula, or some modification of it, this will involve the acceptance of some dynamic conception, such as, for example, has been advocated by Collie and by Bloch. It will be noted that one phase of Bloch's formula corresponds closely to that deduced by Sir William Bragg from his observations on the diamond and on naphthalene and its derivatives.

It should perhaps be pointed out that the above suggestions depend for their validity on the assumption that the relationship between the isomerides is stereochemical in the ordinary sense. There is always a possibility, which, however, will perhaps be generally considered remote, that the difference may be rather one of structure, in that the two compounds contain, for example, different types of nuclei.

J. KENNER.

The University, Sheffield, April 21, 1922.

The Speed of Light.

IN a discussion in NATURE last year (March 10, vol. 107, p. 42) Majorana's experiment was cited as direct proof that the velocity of light is independent of the motion of the source. In reality, however, there is a disadvantage in his method which seems to the writer very greatly to lessen the value of his results.

Majorana measured the wave-length of the green light from a moving mercury-vapour tube by means of a Michelson interferometer, and detected the change of wave-length that is required by the usual Doppler theory (*Phil. Mag.*, 37, p. 145, 1919). Now it is easily seen that the frequency of the waves arriving at the receiving apparatus will undergo the usual Doppler change whether the speed of propagation is altered (moderately) or not, and speed equals wave-length times frequency, hence Majorana concludes that the speed of the light from his tube was the same when the tube was moving as when it was at rest. But obviously he measured the wave-length only after the light had suffered one or two reflections or transmissions in stationary apparatus, and its velocity might easily have been altered by these processes. Any conclusion from his results must therefore rest, at best, upon very indirect reasoning.

We may freely admit that a satisfactory emission theory consistent with all the facts that are known to-day, including Majorana's result, would be difficult to construct. Yet it does seem regrettable that we have still no simple direct proof of the second postulate of Relativity.

Perhaps the simplest way to test the postulate directly would be to observe the Doppler effect with a concave reflecting grating so set as to form the image on the normal to the surface of the grating (cf. Tolman, *Phys. Rev.*, 35, p. 136, 1912); the retardation then occurs entirely before reflection, and it is the wave-length of incident light which is measured by the deviation. Any uncertainty as to the relative speed of the reflected rays can be removed by making the line of motion of the source pass through the centre of the grating, and then observing the effect of the motion upon the position of the central image when the grating is turned so as to bring this image into the position formerly occupied by the diffracted one. In these circumstances, for reasons of symmetry the speed of the incident waves along two rays equally inclined to the direction of motion must be the same; if it then turns out that the position of the central image is unaffected by the motion, it will follow that the speed must likewise be the same along the two corresponding reflected rays. This conclusion will hold also for the two diffracted rays which take these paths in the main experiment.

E. H. KENNARD.
Department of Physics, Cornell University.

On the N-Series in X-Ray Spectra.

WITH the new and very powerful X-ray-spectroscopic outfit constructed by Prof. M. Siegbahn (described in *Comptes rendus*, 1921, p. 1350) I have endeavoured to find a weaker group of lines in the X-ray region than the lines previously known as M-group. I have been able to find some lines which most probably must be referred to the N-series of the elements uranium and thorium. Hitherto, the measured wave-lengths for these lines lie for uranium between 8·6-12·0 A.U. and for thorium between 9·4-13·5 A.U.

From the theoretical and experimental work done by Coster and others, we are able to estimate the wave-lengths of the lines in the N-series. For the elements uranium and thorium we really find that some of these lines must have wave-lengths of about the measured value. For bismuth, however, and the elements in its neighbourhood, all the N-lines must have a wave-length of more than 13 A.U. so that in the present state of spectroscopy it will be very difficult to measure the wave-lengths for these elements.

I am continuing these researches.

V. DOLEJŠEK.
Physical Laboratory, The University,
Lund, March 31.

A Proposed Laboratory Test of the Theory of Relativity.

WITH the present interest so strong in devising experiments to test the theory of relativity, it may not be amiss to suggest the possibility of yet another method. According to recent hypotheses, it seems that the stars are the factories producing complex elements from simpler structures. Inside the stars, hydrogen atoms may unite to form helium, and with hydrogen and helium as intermediates, the more complicated atoms may be built. As pointed out by Harkins, Eddington, Perrin, and others, the synthesis of an atom of helium from four hydrogen atoms necessitates the loss of 0·774 per cent. of the mass of the hydrogen atoms. Since we cannot conceive of mass being annihilated, the only obvious solution is to say that mass is electromagnetic in origin and that, in the helium nucleus, the four protons are brought so near to the two electrons that their fields overlap and neutralise each other to some extent, accompanied by a loss of mass. According to the theory of relativity, 1 gram of matter is equivalent to 9×10^{20} ergs or $2\cdot1\times10^{13}$ calories. Both Harkins and Perrin have calculated the amount of heat that must be produced by the transformation of four gram atoms of hydrogen into one gram atom of helium. It has the enormous value of $0\cdot0078\times2\cdot1\times10^{13}$ or $1\cdot6\times10^{11}$ calories.

It may be possible for several helium nuclei to unite to form heavier nuclei, such as oxygen for example, without such a great evolution of heat. More accurate determinations of the atomic weights of the so-called "pure" elements would be necessary before we could say much concerning the energy relations in such sub-atomic reactions.

When the nuclei become so large that they are unstable, then the process of synthesis in the stars would stop. But there might be an over-shooting of the mark. With the enormous amount of energy free in the interior of the stars, some of this energy might be absorbed, according to the theorem of Le Chatelier, in the formation of nuclei which would be unstable in an environment not containing so much energy. Energy would be considered as one of the terms in a mass law equation, to use a well-known chemical analogy. The result would be the radioactive elements—uranium, thorium, etc.

Now let us calculate with the aid of the above equation, derived from the theory of relativity, the effect on the mass of a radioactive substance that would be caused by this addition of energy. Rutherford, in his book "Radioactive Substances and their Radiations," p. 582, states that 1 gram of radium in disintegrating to lead gives off $3\cdot7\times10^{9}$ calories. If 1 gram of mass $=9\times10^{20}$ ergs $=2\cdot1\times10^{13}$ calories, then 1 gram of radium in disintegrating to lead would give off 0·00017 gram and 1 gram atom of radium, 0·038 gram in the form of energy. If the atomic weight of RaG (radium-lead) is taken as 206 exactly, then the atomic weight of its parent, radium, may be calculated as follows:

1 gram atom of RaG	206·000	grams
5 gram atoms of He	20·000	,,
4 gram electrons	0·0005	,,
$3\cdot7\times10^{9}$ calories	0·038	,,
	226·038	,,

Therefore the atomic weight of radium should be 226·038. Calculations of this type for radioactive substances have been made by Harkins, but he does not state that they may be applied as a test of the theory of relativity.

This calculation involves six assumptions: (1) that the weight of one gram atom of RaG is 206·000, (2) that the atomic weight of He is 4·000, (3) that the weight of 4 gram electrons does not exceed 0·0005 by any great extent when incorporated in the nucleus of Ra, (4) that the amount of energy given off in the disintegration of Ra is substantially that calculated by Rutherford (a 20 per cent. decrease in the value given by him would not change the value for energy in grams in the second decimal place), (5) that the relativity equation connecting mass and energy holds, and (6) that the energy given off in radioactive disintegrations is derived from the atoms themselves and not photochemically from Perrin's hypothetical radiations of extremely short wave lengths. In trying to verify the results of such an equation, there are two more assumptions necessary: that the atomic weights of RaG and of Ra are determined for the pure substances, that there are no contaminating isotopes.

The lowest atomic weights of RaG that have been obtained are those of Richards and Hönigschmid, and are 206·08 and 206·05 respectively. These may be a little high due to admixture of other isotopes of lead. The best value for the atomic weight of radium is 225·97 by Hönigschmid, but the difficulties due to incomplete purification and small quantities of material worked with probably make this value less accurate. Nevertheless, if this figure for radium is accepted provisionally, one must conclude that either radium-lead (RaG) has an atomic weight less than the whole number 206, or that the energy is derived from outside sources as suggested by Perrin, or that the equation connecting mass and energy is not correct.

Now I will suggest a more exact method of testing experimentally the above calculation of the atomic weight of Ra. It is evident that the chemical determinations of the atomic weights of Ra and RaG cannot be made with sufficient accuracy due to difficulties inherent in such determinations and to the probable presence of isotopes in the samples used. When the method of positive ray analysis is extended so that it is accurate to 1 part in 10,000, then we would have a method of determining the masses of Ra, RaG, and He with sufficient accuracy. This refinement does not seem utterly impossible. Though the method is relatively in its infancy, yet Aston claims in the case of helium an accuracy of 2 or 3 parts in 1000. By the positive ray analysis all difficulty with contaminating isotopes in the case of RaG and Ra would vanish. The calculated atomic weight of Ra could be checked by data thus obtained, and the conclusions ought to show whether the relation of mass and energy based on the theory of relativity holds. In any case, the results would be valuable.

Harold S. King.

Wolcott Gibbs Memorial Laboratory of Harvard University,
Cambridge, Mass., U.S.A., March 13.

Safeguarding of Industries Act, 1921.

From time to time complaints have been made in Nature and received at the offices of this Union against the operation of the Safeguarding of Industries Act, 1921. It has been asserted that the Act greatly increases the running cost of laboratories, which are still, to some extent, dependent upon other countries for supplies of scientific apparatus, laboratory ware, and fine chemicals; and this increased cost has fallen upon research and teaching institutions at a time when the Government is restricting grants.

In consequence of the complaints received, this Union approached the British Medical Association, and a joint committee of the two organisations was formed, with the view of exploring the ground, and making representations in the proper quarters. If sufficient information is forthcoming, it is the intention of these two associations to arrange for a deputation to wait upon the Rt. Hon. H. A. L. Fisher, Minister of Education, following upon the suggestion made by Viscount Peel in the House of Lords on November 10 last. It is intended that this deputation should be representative of all scientific and educational bodies, and we are already assured of the support of some of them.

A letter has been addressed to the Deans of the Faculties of Science and Medicine of all British Universities and University Colleges, to Deans of Medical Schools, to Principals of Technical and Agricultural Colleges, and to the Institutes of Physics and Chemistry, and the various teachers' associations. This has asked for information under the five following headings:—

"1. The difficulties experienced by members of your" [University, society, etc.] "in obtaining British materials and laboratory ware of the requisite quality and quantity.

"2. The difficulties experienced in obtaining British scientific instruments.

"3. Detailed particulars of instances where difficulties and delays have been experienced through the action of the customs authorities, in obtaining consignments from abroad. (*N.B.*—It would be well to indicate here from which countries the greater bulk of the goods are obtained.)

"4. The increase in the running costs of laboratories which can be directly attributed to the operation of the Act.

"5. Details of cases where researches have been hindered or had to be definitely abandoned owing to the difficulties of obtaining materials from abroad or their excessive cost in this country."

A fair number of replies has been received, though in many cases the information given is not in sufficient detail. I should be glad, therefore, if all scientific workers, including those engaged in industry, would supply me with detailed information under these five headings at the first opportunity.

A. G. Church,
General Secretary.

National Union of Scientific Workers,
25 Victoria Street, Westminster,
London, S.W.1.

Discovery of Gold in Devonshire.

I had occasion recently to conduct a party of my students from King's College, London, over the Devonian rocks in the neighbourhood of Torquay, Devon, and had the good fortune to discover an interesting occurrence of gold in the fault-rock of a small fault cutting the limestones near Hope's Nose. As it may prove of some interest, I take the opportunity of recording the find in the columns of Nature.

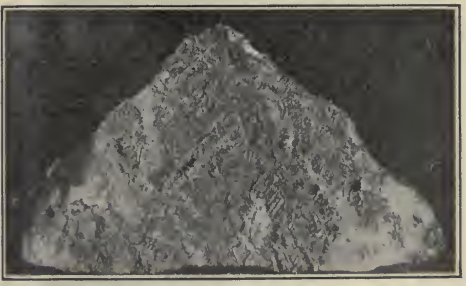

Fig. 1.—Dendritic gold in Devonian limestone. (×3.)

The fault-rock is a limestone-breccia cemented by crystalline calcite, through which the gold is distributed in a dendritic fashion, as indicated in the accompanying figure (Fig 1). It is premature to dogmatise on the possible commercial value of the gold, since time did not permit of a thorough examination of the locality, and a former find at Daddy's Hole proved too poor to work, but it is intended to proceed further with the matter in case it may prove worth exploitation.

W. T. Gordon.

Artificial Disintegration of the Elements.[1]

By SIR ERNEST RUTHERFORD, F.R.S.

SINCE the development of the atomic theory on an experimental foundation by Dalton, the progress of chemistry has been based on the central idea of the permanency and indivisibility of the atoms of the elements. The whole experience of chemistry for nearly a century had shown clearly that it was impossible to break up the atoms of the elements by the application of ordinary chemical and physical processes. This idea has had to be modified to some extent by the rapid growth of our knowledge during the last twenty years of the inner constitution of the atoms.

It is now generally accepted that the atoms of the different elements have all the same general type of structure. At the centre of the atom is a positively charged nucleus of minute dimensions which is responsible for most of the mass of the atom. This is surrounded by a distribution of electrons held in equilibrium by the forces from the nucleus. The electrons occupy rather than fill a region the diameter of which is of the order of 2×10^{-8} cm. The nuclear charge of the atoms follows a very simple rule first clearly brought to light by Moseley. The resultant nuclear charge of an atom is equal to its atomic or ordinal number, and varies from 1 "atom" of electricity in the case of hydrogen to 92 in the case of uranium. These ordinal numbers represent also the number of "planetary" electrons, as they have been called, which surround the nucleus of the atom. On this view of the atom, its ordinary physical and chemical properties, apart from its mass, are governed entirely by the nuclear charge, for this controls the number and arrangement of the external electrons on which these combining properties mainly depend. The mass of the atom is a property of the nucleus and exercises only a second order effect on the distribution of the electrons and so on the ordinary properties of the atom.

This point of view offers at once a simple explanation of isotopes, which consist of atoms of the same nuclear charge but of different nuclear masses. By the action of light and electrical discharges, we can readily remove one or more of the external planetary electrons from the atom, while by the action of X-rays and swift β-rays we may even eject one of the more strongly bound electrons of the system. In this way, we can effect, in a sense, a transformation of the atom, but it is merely a temporary one, and a new electron is soon captured from outside, and the atom is as before. The general evidence indicates that, even if a number of the planetary electrons were removed by suitable agencies, the stability of the nucleus would not be disturbed and the atom would in a short time regain its original structure. In order to effect a *permanent* change in the atom, it appears to be necessary to disrupt the nucleus itself. When once a charged unit of the nuclear structure is removed, the nuclear charge is altered permanently, and there is no evidence that this process is reversible under ordinary experimental conditions.

The discovery of the instability of the radioactive elements was the first severe shock to the idea of the permanency of all atoms. This radiating property is, however, confined mainly to the two heaviest elements, uranium and thorium, and their long series of descendants, and is shown only by two other elements, potassium and rubidium, and then only to a minor extent. Apart from these exceptions, the great majority of the atoms appear to be exceedingly stable structures, and to remain unaltered under ordinary conditions in this earth for periods of probably thousands of millions of years.

The property of radioactivity belongs to the nucleus, and is shown generally by the emission of a swift α-particle or helium nucleus and, occasionally, a swift electron or β-ray from the nucleus. The number and velocity of emission of these particles appear to be quite uninfluenced by the most powerful physical or chemical agencies, and to be an inherent property resulting from the instability of these very complex nuclei.

These results show clearly that the nuclei of heavy atoms contain both positively charged helium nuclei and negative electrons, and lead to the general view that the complex nuclei of all atoms are built up of hydrogen and helium nuclei and electrons. It is also generally supposed that a helium nucleus itself is a secondary unit composed of four hydrogen nuclei and two electrons. If this be the case, we may suppose the nuclei of all atoms to be composed ultimately of hydrogen nuclei, or "protons," as they have been termed, with the addition of negative electrons.

Radioactivity has thus not only provided us with the key of the structure of the elements, but has at the same time given us in the swift α- and β-particles a powerful method of probing the inner structure of the atom. By firing α-particles into the atoms of matter, we are able, by following the deflexions of the path of the α-particle, to find out the magnitude and law of the forces close to the nucleus and to form some idea of the dimensions of the latter. The general results suggest that the diameter of the nucleus of heavy atoms is of the order of 4×10^{-12} cm. or about 1/5000 of the diameter of the whole structure of the atom. The law of the inverse square of repulsion between electric charges is found to hold for a considerable region surrounding the nucleus. No doubt the size of the nuclei of light atoms is even smaller, and in the case of helium appears to be of the order of 5×10^{-13} cm. It is thus clear that the nuclei of atoms, although of very complex structure, are of exceedingly small dimensions.

It is probable that the forces which bind together the components of the nucleus are exceedingly powerful, and that consequently a large amount of energy will be required to disrupt its structure. The swift α-particle from radium or thorium, which is by far the most concentrated source of energy known to us, seems the agent most likely to succeed in an attack on the strongly-bound nucleus. The α-particle is expelled from radium with a velocity of about ten thousand miles per second, and thus has a speed twenty thousand

[1] A Lecture delivered before the Chemical Society on February 9.

times greater than that of a swift rifle bullet. Mass for mass, its energy of motion is four hundred million times greater than that of the bullet.

Whilst no doubt an α-particle fired directly at a heavy nucleus may penetrate its structure, its energy may at that stage be too small to cause a disruption. The attack on the lighter atoms is much more promising, for the repulsive forces are so much smaller that the α-particle may still retain much of its energy on entering the nuclear structure.

Before, however, considering experiments on this question, it is desirable to say a few words on the collision of α-particles with hydrogen nuclei, where no question arises of the disruption of the atom. When α-particles pass through hydrogen gas, there are occasional close collisions between the α-particles and the hydrogen nuclei, resulting in the appearance of high speed H-nuclei. These H-particles travel about four times the distance of the bombarding α-particle, and can be detected easily by the scintillations they produce on a zinc sulphide screen. From the ordinary principles of mechanics, the maximum speed given to an H-nucleus is 1·6 times that of the colliding α-particle, whilst the maximum energy communicated to it is 0·64 of the energy of the α-particle. It is found that the number of these swift H-atoms is far in excess of that to be expected if it be supposed that the α-particle and hydrogen nucleus behave as point charges for the very small distances involved in these violent collisions. In addition, the variation of the number with the velocity of the α-particle and the number shot off at different angles with the direction of the α-particle differ markedly from the results to be expected on the simple point theory.

It seems clear that not only has the α-particle a structure, but that the law of force at very short distances is entirely different from that of the inverse square. As a result of a careful investigation, Chadwick and Bieler concluded recently that the results of the collisions could be explained by supposing that the α-particle—to which the complexity is ascribed—behaves like a spheroid of axes 8×10^{-13} and 5×10^{-13} cm. Outside this surface, the law of the inverse square applies, but the forces increase so rapidly when the H-nucleus enters the spheroidal surface that it is rapidly turned back. This model of the helium nucleus is, no doubt, quite artificial, but it gives us some idea of its probable dimensions and the extent of the region in which new and powerful forces come into play.

We should consequently anticipate that, in a close collision of a swift α-particle with the nucleus of an atom more complex than that of hydrogen, the ordinary laws of force would break down when the distances separating the particle and nucleus became very small. It must be remembered that gigantic forces come into play in these nuclear collisions, and only very stable structures may be expected to survive the encounters.

The first observation which has to do with the main subject of my lecture was made some years ago. When the α-rays from a strong radioactive source pass through dry gases like oxygen or carbon dioxide, a small number of weak scintillations are observed on a screen beyond the range of the α-particles. These "natural" scintillations are believed to be due to atoms of hydrogen coming from the source, and probably result from a slight hydrogen contamination of the source during exposure to the radium emanation. If, however, dry air is substituted for oxygen or carbon dioxide, the number of scintillations is increased three or four times. This additional effect was found to be due to the presence of nitrogen, and was shown in a correspondingly greater degree by chemically prepared nitrogen. By suitable arrangements, it was found that the particles causing these scintillations were bent by a magnetic field to about the extent to be expected if they consisted of swift, charged H-atoms. It seemed probable from the beginning that these additional H-atoms, which appeared only in dry nitrogen and not in oxygen or carbon dioxide, must have their origin in a disintegration of the nitrogen nucleus by collision with a swift α-particle.

With the original counting arrangements, the scintillations were small in number, weak in intensity, and difficult to count with accuracy. Further progress has depended mainly on improvements in the counting microscope, with the object of increasing the intensity of the scintillations and the area of zinc sulphide screen under observation. By the use of wide-aperture objectives and special eyepiece lenses of low magnifying power, the counting of these scintillations has become much easier and more definite.

We shall now consider the methods adopted to investigate in more detail the effects observed in nitrogen and to test whether other elements behave in a similar way. The apparatus required is of the simplest character and consists merely of a brass tube, 3 cm. in diameter, provided with stopcocks by means of which dry gases may be circulated through it. At one end of the tube is a hole covered with a thin silver plate. The zinc sulphide screen is fixed 1·3 mm. away from the opening, leaving a slit in which absorbing screens of mica can be inserted. The radioactive source is fitted on the end of a rod so that its distances from the screen can be varied at will. In order to reduce the luminosity due to the β-rays from the source, the whole apparatus is placed in a strong magnetic field. It may be of interest to give a few details in illustration of the magnitude of the effects to be expected under different conditions. Suppose that the radioactive source, consisting of a brass disk coated on one side with an invisible layer of radium-C corresponding in γ-ray activity to 40 milligrams of radium, is placed 3·5 cm. from the screen and that a current of dry hydrogen is passed through the apparatus. Suppose the stopping power of the materials between the source and the zinc sulphide screen corresponds to 20 cm. of air, that is, it would suffice to stop an α-particle of range 20 cm. in air. The passage of the α-particles, which in this case have a range of 7 cm., through the hydrogen liberates a large number of high-speed H-atoms, which produce scintillations on the screen. Their number, seen through a special microscope which has a field of view of 40 sq. mm., is so great—thousands a minute—that it would be impossible to count them without reducing the activity of the source. As additional absorbing screens of mica are added, the numbers fall off rapidly, and for an absorption of, say, 30 cm. not a single H-scintillation can be observed per minute. A similar effect is shown if oxygen is substituted for hydrogen

and a thin strip of paraffin wax or other hydrogen material is placed over the source. The number of H-scintillations observed for a given absorption depends only on the amount of hydrogen, and is quite independent of chemical combination. This is to be expected, for the forces required to set the H-nucleus in rapid motion are enormous compared with the weak forces involved in chemical combination. We thus conclude that, for α-particles of range 7 cm., no H-atoms from hydrogen in the free state or in chemical combination can be detected for an absorption greater than 30 cm. of air.

The oxygen which gives no scintillations is now replaced by dry air. At once we observe for an absorption of 30 cm. more than 100 scintillations per minute when for hydrogen we did not observe one. By adding mica screens we find that the scintillations cease for an absorption of 40 cm. It is clear that these particles, which come from nitrogen, have a greater range than free H-atoms bombarded by α-rays, so that the effect observed beyond 30 cm. cannot be ascribed to any hydrogen impurity in the nitrogen.

The air is now replaced by neutral oxygen, and thin foils of say copper, iron, silver, gold of stopping power corresponding to about 3 cm. of air are placed successively over the source. Not a single H-atom can be observed for an absorption of 30 cm. A piece of aluminium foil is substituted and at once the number of scintillations jumps to more than 100 per minute. Some of the scintillations are very bright, and we find that some of the particles are so swift that the absorption must be increased to 90 cm. before the scintillations vanish. It is clear that aluminium must give rise to a number of very long-range particles.

Thus if we examine the number of scintillations beyond the range of ordinary H-atoms, we are quite independent of any possible contamination of hydrogen in the material under examination. This is a great advantage, for we need not concern ourselves about the purity of the material as regards hydrogen. In this way, Dr. Chadwick and I have examined a large number of elements to test whether they emit particles of range more than 32 cm. When the element was not available, a compound of the element with an "inactive" element like oxygen was used. The material in the form of a fine powder is dusted on a thin gold foil, an adhesive film being used so that the average absorption of the material corresponded with 3-4 cm. of air, and was then exposed to the source of rays. With the exception of helium, neon and argon, all the elements up to atomic weight 40 have been tested. No element of atomic weight greater than phosphorus, 31, was found to give any effect, although it should be said that only a few of the elements of higher atomic weight have so far been examined.

A list of the elements examined in this way, from lithium to sulphur inclusive, is given in the following table. The second column gives the number of scintillations per minute per milligram activity of the source, namely, radium-*C*, for an absorption of 32 cm. of air. These numbers afford only a rough comparison of the effects given by different elements, for the conditions of the experiment, for example, the thickness and distribution of the film of material, varied from element to element. The fourth column gives the approximate range of the particles.

Element.	Material.	No. of particles per min. per mg. for the microscope used.	Maximum range of particles in cm. of air.
Lithium	Li_2O	—	—
Glucinum	GlO	—	—
Boron	B	0·15	*ca.* 45
Carbon	CO_2	—	—
Nitrogen	Air	0·7	40
Oxygen	O_2	—	—
Fluorine	CaF_2	0·4	over 40
Sodium	Na_2O	0·2	*ca.* 42
Magnesium	MgO	—	—
Aluminium	Al, Al_2O_3	1·1	90
Silicon	Si	—	—
Phosphorus	P (red)	0·7	*ca.* 65
Sulphur	S, SO_2	—	—

In addition to these, the following elements of higher atomic weight were examined: chlorine as $MgCl_2$; potassium as KCl; calcium as CaO; titanium as Ti_2O_3; manganese as MnO_2; iron, copper, tin, silver, and gold in the form of metal foils. In no case were any particles observed of range greater than 32 cm. of air. The question whether any of these elements give particles of range less than 32 cm. has not been examined.

It will be seen that the elements which give scintillations for an absorption of 32 cm. are boron, nitrogen, fluorine, sodium, aluminium, and phosphorus. The numbers for boron and sodium were distinctly less than for the other elements.

(*To be continued.*)

The Royal Academy.

THE representative of NATURE looking for points of scientific interest amongst the fourteen hundred or so annual exhibits at the Royal Academy may be excused if he sometimes feels depressed and is reminded of the proverbial searcher after a needle in a haystack, in so few of the pictures do objects having any direct connection with science appear. It has in past years been remarked that purely scientific work does not yet appeal to the Academy artist, and it is necessary to turn for points of interest to nature scenes such as may be found in pictures of sea, sky, snow, and country life.

In snow scenes J. Farquharson frequently has successful effects and "The Edge of the Forest" (239) this year is quite up to his standard. Another good snow effect, in this case associated with water, is contained in "A Yorkshire Bridge in Winter," by F. E. Horne (884). A successful landscape somewhat of the Leader type, the central feature of which is a group of pine trees, is shown by Frank Walton in 591. It is a pity that there is only this one example of his work in the exhibition. The title which A. J. Munnings has chosen for No. 111 does not lead one to expect a landscape, but the setting of the portraits which give

the name to the picture is a wide expanse of country with distant blue hills in the background showing delightful lights and shades. The effect is spoilt rather than improved by the somewhat wooden sitters so obviously posing in the foreground.

Turning to agricultural scenes, the two ploughs seem out of place alongside the rick in "Farm Lands in Sussex" (459) while hay still lies in the field uncarted. Again in "Harrowing" (827) the crop seems to consist of heather, surely a somewhat unusual occupation.

In "A Summer Gale" (610) R. G. Brundrit has quite failed to convey the impression of a gale, ordinary cumulo-nimbus which might be associated with a shower being all that is indicated in the picture. The idea of a gale is introduced more effectively in Sir Arthur Cope's "An Evening in October" (750), though wind is not mentioned in this case. A very direct reference to the work of the Meteorological Office is made in "The South Cone" (250), though it is not indicated which of the two hundred gale warning stations round the British coasts is referred to. The warning seems to have been successful, judging from the flag at the masthead and the spray dashing against the shore, but the sea in the foreground, curiously enough, is scarcely rippled. The reference to a forecast in the title of 175, "A Hopeful Forecast," suggests further possibilities of reference to the work of the Meteorological Office, such as a forecaster studying the movements of Bjerknes' Polar Front, or plotting ships' observations received by wireless telegraphy from the Atlantic and deducing the probability of a week of fine weather. But any such expectations are destined to be disappointed, since what the picture reveals is a young lady with golf clubs tapping an old dial type of barometer, the hand of which is hard over in the "Set Fair" position.

Rain falling at a slant owing to the difference in velocity of upper and lower wind currents is a common sight, but Norman Wilkinson has shown the increase of wind aloft in a striking manner through the agency of falling rain in his picture of the King's yacht *Britannia* racing in a squall (395). The wind is blowing across the picture from left to right and making the yacht heel over until the mainsail is awash, while in a shower near by the rain slants backwards as it falls through air of diminishing velocity. One is almost tempted to commence calculating the rate of change of velocity with altitude.

An optical phenomenon figures prominently in "The Charcoal Burner's Hut" (632), where bright coloured rings surround the moon at a radius which is too small for a halo, while of unusual size for a corona; but such varied optical forms have been seen in the sky from time to time that it is unwise to dogmatise upon the unreality of this representation.

Adrian Stokes' "Sunset" (188) is suggestive of a sun pillar in the bright vertical extension above the sun, though it is improbable that a real sun pillar was the source of his inspiration. The moonlit scene in 80, "The Dead of the Night," is curious from the whiteness of the tower and wall in the moonlight and yet the absence of shadows where these would be expected under the trees.

Much interest naturally attaches to W. L. Wyllie's picture of the towing of the old *Victory* into her resting-place in dry dock. The execution of the water in Portsmouth Harbour is so good that the frame at the lower edge of the picture causes quite a shock, the eye being deceived by the reality of the representation. J. Olsson has a pleasant sea and island scene in the Scillies (42), which gains greatly over some former works by restraint in the use of brilliant colouring.

This year's exhibition is conspicuous for the number of portraits it contains, these forming a more than usually high proportion of the whole. It is gratifying to notice in a place of honour in one of the principal galleries, and adjacent to a painting of the Royal Wedding, a portrait of Sir Charles Parsons by Sir W. Orpen. Men of science are not numerously represented, and careful search was needed to disclose a tablet of Sir William Ramsay destined for Westminster Abbey and a silver medallion of Prof. James Thomson for Belfast University.

J. S. D.

Obituary.

SIR PATRICK MANSON, G.C.M.G., F.R.S.

THE death of Sir Patrick Manson, which occurred in London on April 9, has taken from the medical profession one of its most distinguished leaders. Born in 1844, and educated at his native University of Aberdeen, Manson decided to follow his calling in the Far East, and in 1866 went to Formosa, whence in 1871 he moved to China, where he continued during eighteen years. From the very beginning of his career Manson made the causation of disease his study. He was naturally interested in the elephantiasis so prevalent around him, but it was not until 1874, when he came home to marry a wife, that he learned fully of Lewis's discovery of a microscopic filaria (now known as *Microfilaria bancrofti*) in the blood of Indian sufferers from the chyluria often associated with that disease.

On his return to China he settled down to the study of "elephantoid" pathology, and began with a survey of the blood of a thousand Chinamen. Having satisfied himself that the microfilariæ found in the blood are the issue of parent filariæ locked up in the lymphatics of the host—a discovery in which, however, he was anticipated by Bancroft of Brisbane—and that they are embryos incapable of any further development in the blood, he saw that the series of events by which the microfilariæ living in the blood of one man became the adult filariæ living in the lymphatics of other men must take place in the outside world, and might possibly be initiated by some such free-ranging, blood-sucking insect as a mosquito. His selection of the mosquito was decided by his further discovery that the microfilariæ make their show in the cutaneous blood of their host only after sunset, when mosquitoes are active; in the daytime they flock to the host's lungs and central blood-vessels. In 1877, with the compliance of an infected Chinaman, he put his theory

to the proof and found that it corresponded with fact: the microfilariæ were sucked into the stomach of his mosquitoes, and some of them migrated into the insects' tissues and there underwent definite changes of growth and development, and were thus set on their course, *via* the infected mosquito, for infecting other human beings.

It must be borne in mind that Manson was a busy medical practitioner working, far off and alone, as he could find time, and without particular appliances. It is not surprising, therefore, that he did not follow the exact course taken by infected mosquitoes in transferring their infection to man. He was content to have demonstrated the essential realities of a great original conception, and to have established the great pathogenetic discovery—so pregnant with further possibilities of knowledge, so abundant in its practical applications to human welfare—that a common blood-sucking insect is *the essential factor* in the maintenance and dissemination of a widely-diffused parasitic disease.

In 1894, when he had left China, Manson found his opportunity of applying this great principle to the problem of malarial infection. He had followed all the work that had been done on the parasites of malaria since their discovery by Laveran in 1880, and he had come to the conclusion that the secret lay in the motile filaments extruded from forms of the parasite now known to be male gametocytes. Other observers regarded these filaments as degenerations: Manson interpreted them in the light of his filaria observations. He argued that as the forms that produce them are so persistent and resistant, the filaments must have some vital meaning; that since they are not produced until the blood has been shed, their destiny lies in the outside world; and that since they cannot get out spontaneously, they possibly are extracted and nursed—like the microfilariæ—by mosquitoes. This is Manson's mosquito-malaria theory, that inspired and guided Ross in his wonderful discovery of the sexual cycle of the malaria parasite and final solution of the problem of malarial infection. The theory has sometimes been referred to as if it were one of the several ingenious speculations that have attributed the spread of malarial fevers to mosquitoes: quite otherwise; it stands apart as a closely-reasoned working hypothesis based on known facts in the history of the malaria parasite and legitimate inferences from the history of *Filaria bancrofti*. Ross, writing with all the combined authority of an historian and a malariologist, says of it (NATURE, vol. 61, 1900, p. 523): "Manson's theory was what I have called it—an *induction*—a chain of reasoning from which it was impossible to escape. . . . I have no hesitation in saying that it was Manson's theory, and no other, which actually solved the problem; and, to be frank, I am equally certain that but for Manson's theory the problem would have remained unsolved at the present day."

Manson had retired from China in 1890 and settled in London. In 1894 he joined the staff of the Seamen's Hospital, and in 1897 was appointed Medical Adviser to the Colonial Office. He was now able to realise his lifelong dream of a school in London where medical men going to the tropics could acquire all the necessary craftsmanship that he himself had yearned after in his early days in China. In this design he happily obtained the countenance of Joseph Chamberlain and the co-operation of the Seamen's Hospital Society, and in 1899 the London School of Tropical Medicine was established under him at the Albert Dock. Here, until his retirement from all active practice in 1913, he radiated rather than imparted wisdom and inspiration to many hundreds of his younger professional brethren; and here, under his sage and benign influence, there grew up a sort of Mansonian tradition that for useful work in the tropics a medical man, though always a clinician at heart and a sanitarian in his general outlook, must be a biologist in his attitude to pathology and ætiology.

Manson's place in the history of medicine can be estimated only when we consider how much of what for convenience we speak of as "tropical disease" is due to animal and animalcule parasites, and to what extent those parasites are fostered and diffused by blood-sucking arthropoda. Men before Manson had speculated on the pathogenetic possibilities—or even probabilities—of predaceous insects, but no man before him had followed—or gone near following—a specific pathogenic organism into a specific predaceous arthropod and discovered what happened to it there. "The light of humane minds," says Hobbes, "is perspicuous words, by exact definition snuffed and purged from ambiguity": it is Manson's pre-eminent distinction to have been the first to discover a connected series of facts and to have recorded them in exact definitions purged and snuffed from ambiguity—which is the acquisition of science. With Manson's high achievements as an original investigator and a teacher we have to consider also his extraordinary influence as a most prescient clinician—and a clinician who never forgot the comfort of his patients: in all this, as in his large humanity and his benevolent attitude to his fellow-workers, he worthily upheld the ideal of Hippocrates; and I have often thought that, as the Father of Tropical Medicine, his name may, perhaps, have the same lasting fragrance as that of his immortal archetype.

A. A.

SIR A. B. KEMPE, F.R.S.

SIR ALFRED BRAY KEMPE, whose death occurred on April 21, was born in 1849, and educated at St. Paul's School and at Cambridge, where he was twenty-second Wrangler. His first contribution to the science of mathematics was in 1876, when, in a paper on a general method of describing curves of the *n*th degree by link-work, he laid the foundation of the excellent discoveries he was destined to make in "linkages"—a subject in which he took a lifelong interest. In 1877 he gave his well-known lecture, "How to draw a straight line," in which he traced the history of the connection between the straight line and linkages from the partially successful attempts of Watt, Richard Roberts, and Tchebicheff, to the practical solution of the problem by Peaucellier in 1864. Together with Hart of Woolwich Academy and Sylvester he had added much to the knowledge of the subject, and these additions he described with models.

A paper on conjugate 4-piece linkages followed in 1878, and some smaller papers, but Kempe's principal

contributions appeared in the years 1885–86. The "Memoir on the Theory of Mathematical Form" is a first-rate piece of work. Its avowed object is to separate the necessary matter of exact or mathematical thought from the accidental clothing—geometrical, algebraical, logical, etc.—in which it is usually presented for consideration, and to indicate wherein consists the infinite variety which that necessary matter exhibits. This long and thoughtful research shows that as a thinker Kempe perhaps resembled W. K. Clifford more than any one else has done in the world of science. This indeed was recognised by Spottiswoode, who, coming into possession of "Mathematical Fragments" which had been reproduced in facsimile from the papers left by Clifford, decided to send them to Kempe. He dealt with them, and finding inspiration in the graph theory which they contained he wrote a very valuable and suggestive paper upon the "Application of Clifford's graphs to ordinary binary quantics." Clifford had not at the time of his death succeeded in effecting this, and it required a man like Kempe who was well versed in the rapidly growing theory of invariants to accomplish it.

In 1894–96 Kempe was president of the London Mathematical Society. In his valedictory address he dealt in a thoughtful and learned manner with the question of defining the subject matter of mathematical science. He finally suggests the statement, "Mathematics is the science by which we investigate the characteristics of any subject matter of thought which are due to the conception that it consists of a number of differing and non-differing individuals and pluralities." Here we can trace the influence of his studies of mathematical form. He always tried to behold the objects of his thoughts in their lowest terms freed so far as possible from all extraneous matter, and it is greatly to be regretted that, shortly after vacating the chair, he became so busy with the duties thrown upon him by his acceptance of the position of chancellor to several dioceses that his direct contributions to science, from which much might have accrued, came to an end.

Indirectly, however, Kempe was for the remaining years of the greatest service to science. Those which he rendered to the Royal Society as treasurer have been described elsewhere. It must be added that from that position he was *ex officio* treasurer of the National Physical Laboratory from its foundation until April 1918, and he was able to do much for that great institution and for its director and executive committee. He never failed to attend particularly the finance committee, and was always fully informed as to the details of finance. His help and advice, often sought, was given ungrudgingly, and it may be said that it was owing largely to him that the funds necessary for maintaining and developing the laboratories were obtained. In the scientific life of the country he took a notable position. He was universally popular and respected. P. A. M.

SIR WM. PHIPSON BEALE, BART., K.C.

SIR WILLIAM BEALE died at Dorking while on a visit to friends, on Thursday April 13, at the ripe age of eighty-two, in full possession of his faculties. His remains were cremated at Golders-green on April 19; a service in his memory was held in Lincoln's Inn Chapel on April 26. His qualities had endeared him to a wide circle of intimates, in scientific, legal and political society, by whom his loss will be deeply mourned.

Beale's early training was that of a chemist, the intention being that he should enter an ironworks at Rotherham in which his family was interested. He made a beginning in the laboratory of Mr. Hill, a well-known consulting chemist in Birmingham; he then studied in Heidelberg and Freiberg, finally in Paris. At Heidelberg he was brought into contact with a number of chemists who afterwards became well-known—Matthiesen, Mond, Roscoe, Russell and others.

After but a short stay in the ironworks, Beale turned his attention to the law as offering better prospects; he entered Lincoln's Inn in 1867. Throughout his life, however, he retained his scientific interests and long acted as honorary legal adviser to the Chemical Society. He was one of the most popular and active members of the now defunct B club, a club of chemists whose doings have been chronicled by Dr. A. Scott in one of his Presidential addresses to the Chemical Society. At Freiberg Beale became interested in mineralogy and crystallography. When, in later years, the subject was developed and he desired to modernise his knowledge, I was able to hand him over to William Pope, then active as demonstrator of crystallography in my department at the Central Technical College; they contracted a firm friendship. Later on Beale even wrote a treatise on the subject, in which he put forward an original graphic method of presenting the facts of crystal symmetry. He was many years Treasurer and finally President of the Mineralogical Society. He also took an active interest in the Royal Institution.

Beale entered Parliament, after several ineffective attempts at Birmingham, as Liberal member for South Ayrshire, in 1906, retaining his seat until he resigned in 1918. He enjoyed a high reputation in legal and political circles, on account of the breadth and accuracy of his knowledge and his wonderfully balanced sane judgment. Of late years he spent much of his time, always surrounded by friends, at his Scotch home, near Barrhill in Ayrshire, most beautifully placed on an open grouse moor in sight of the Galloway Cauldron, Merrick, the highest peak in South Scotland, being a prominent feature in the view. Geikie's "The Ancient Volcanoes of Great Britain" was not infrequently taken down from his shelves. H. E. A.

SIR A. P. GOULD.

SIR ALFRED PEARCE GOULD, whose death at the age of seventy years we announced last week, had been a member of the honorary staff of the Middlesex Hospital since 1882, and was a consulting surgeon at the time of his death. He was a Fellow of the Royal College of Surgeons and a Master of Surgery at the University of London, of which he was Dean of the Faculty of Medicine 1912–16, and Vice-Chancellor 1916–17. His publications include the "Elements of Surgical Diagnosis," which went into five editions, and the Bradshaw Lecture on Cancer (1910). He was joint author of the "International Text-Book of Surgery." Though a surgeon of wide interests, Sir A. P. Gould devoted much work to the study of the clinical treatment of cancer, and was early in recognising the valuable

adjuncts which X-rays and radium were to prove in the treatment of malignant disease. At the Middlesex Hospital he acted for a number of years as chairman of the Cancer Investigation Committee, and thus held a watching brief for any new remedial agent likely to prove of benefit in the treatment of cancer. He was an excellent teacher and did not spare himself in the many services which he was asked to undertake. He was at some time president of the clinical section of the Royal Society of Medicine, of the Medical Society of London, and of the Röntgen Society. Throughout the period of the war he acted as Officer-in-Charge of the Surgical Division of the 3rd London General Hospital at Wandsworth.

Current Topics and Events.

DR. E. H. GRIFFITHS, the General Treasurer of the British Association, informs us that Sir Charles Parsons has conveyed to the Trustees of the Association a gift of ten thousand pounds 5 per cent. War Loan Stock, which he has placed unreservedly at the disposal of the Council. This generous gift comes at a very opportune time, as the finances of the Association have suffered depletion during the past seven years, and there was a danger that the activities of an association which has rendered such notable services to science in the past might suffer restriction. It is interesting to note that the total sum granted in aid of research by the Association, since its foundation in 1831, exceeds 83,000*l*.

THE Mount Everest Expedition, with the exception of Messrs. Finch and Crawford, who are delayed by the transport of the oxygen apparatus, arrived at Khampa Dzong on April 11. General Bruce's despatch to the *Times* describes the march from Phari Dzong. Considerable difficulty was experienced in obtaining a sufficiency of transport animals. The Tibetan authorities did their best, but owing to the earliness of the season many of the animals were in very poor condition. The expedition travelled in two divisions and found the march very trying. On the Dongka pass, where ridges of 17,000 ft. had to be crossed, low temperatures were experienced, but fortunately the blizzard experienced on the previous day had ceased. All members of the expedition are in good health, the trying experiences having affected neither the white men nor the hillmen.

THE Bessemer Gold Medal of the Iron and Steel Institute for the year 1921 has been awarded to Mr. Charles Fremont, in recognition of his services in the advancement of the metallurgy of iron and steel and the technology of the testing materials. The following grants from the Andrew Carnegie Research Fund were made during the year by the council of the Institute: 100*l*. to Dr. L. Aitchison, Birmingham, for the investigation of the low apparent elastic limit in quenched and work-hardened steels, with particular reference to fatigue strength, proof stress, and constitution; 100*l*. to Prof. C. O. Bannister and Mr. A. E. Findley, Liverpool, for the investigation of the mechanical properties and heat treatment of very low carbon high chromium steels; 100*l*. to Mr. F. C. Langenberg, of Watertown Arsenal, United States, for research on impact testing; and 50*l*. to Mr. J. N. Greenwood, Sheffield, for research in optical data of steels and steel-making materials necessary for correcting temperature measurements of molten steel taken with an optical pyrometer.

THE Third Hurter and Driffield Memorial lecture of the Royal Photographic Society is to be delivered at the Royal Society of Arts, at 8 o'clock, on Tuesday, May 9, by Prof. The. Svedberg, who will take as his subject "The Interpretation of Light Sensitivity in Photography."

AT the annual general meeting of the Manchester Literary and Philosophical Society held on April 25, the following officers and members of council were elected:—*President:* Mr. T. A. Coward; *Vice-Presidents:* Sir Henry A. Miers, Mr. W. Henry Todd, Prof. Arthur Lapworth, and Mr. C. E. Stromeyer; *Hon. Secretaries:* Dr. H. F. Coward and Prof. T. H. Pear; *Hon. Treasurer:* Mr. R. H. Clayton; *Hon. Librarians:* Mr. C. L. Barnes and Dr. Wilfrid Robinson; *Hon. Curator:* Prof. W. W. Haldane Gee; *Members of Council:* Dr. W. M. Tattersall, Prof. F. E. Weiss, Mr. Francis Jones, Miss Laura Start, Prof. S. Chapman, Prof. W. L. Bragg, the Rev. A. L. Cortie, Mr. R. L. Taylor, and Mr. William Thomson.

A PROVISIONAL programme has been issued of the annual general meeting of the Society of Chemical Industry to be held in Glasgow on July 4-11 next. On the first day of the meeting, formal business will be discussed and Dr. R. F. Ruttan will deliver his presidential address. During the morning of July 5, Prof. H. E. Armstrong will give the Messel Memorial lecture, while on the following day a novel feature will be introduced in the form of a demonstration of kinematograph films showing the manufacture of rubber, the production of sulphur, and the preparation of paper from wood. The Chemical Engineering Group of the Society will hold two sessions on July 6, at which papers on the design of ammoniacal liquor stills, tar and glycerine distillation, and the general problem of evaporation will be read. Visits to various works, among which are the Nobel Industries, Ltd., and several excursions, will occupy the remaining portions of the meeting.

AT the fifth annual general meeting of the Society of Glass Technology held on April 26, Prof. W. E. S. Turner was elected president. In his presidential address entitled "The British Glass Industry: its

Development and Outlook," Prof. Turner gave an account of the growth of the British glass industry from the time of the Roman occupation onward. Speaking generally, there was a steady growth up to the year 1875, after which time the number of glass factories began to decrease and the imports of finished glassware increased. This steady decline was arrested on the outbreak of war in 1914, and during the last few months of 1914 and 1915 the industry was revived. New branches were created under the stress of war for the production of chemical glassware and for lampworking. They grew to such an extent that during the last twelve months of the war period more than two million pieces of chemical glassware were made at the furnace, and some 39 million lampblown articles and more than a million pounds of glass rod and tubing were manufactured. The output of electric lamp bulbs exceeded 43 millions, as compared with four million bulbs of pre-war years. Turning to the future, Prof. Turner acknowledged that the immediate outlook was not cheerful, but claimed that the industry was much more efficiently equipped than at any other time in its history.

We have received a communication, dated March 23, from Mr. Y. Venkataramaiah, Calcutta, in which he states that the plastic sulphur separating in the action of concentrated nitric acid on a crystal of sodium thiosulphate, which is ordinarily yellow, becomes distinctly green if a little colloidal gold or platinum solution is added to the acid before the addition of the thiosulphate. Sometimes small blue spots are visible on the separated sulphur. Colloidal gold appears to be more effective than colloidal platinum. The sulphur dissolves in carbon disulphide forming a light greenish solution; when treated with absolute alcohol it becomes yellow. It dissolves in hot methyl salicylate, and nacreous sulphur separates on cooling.

In a lecture delivered to the Société de Chemie Physique in February 1921, M. Edmond Bauer gave an excellent account of the present state of atomic physics, and the lecture has now been published by the society, in a pamphlet of about 50 pages entitled "La Théorie de Bohr, la Constitution de l'Atome et la Classification périodique des Éléments." It starts with the various atomic models, contrasting the rival merits of the static and the dynamic. There is then a description of the work on atomic numbers, both that originating with the X-ray work of Moseley, and that from Rutherford's theory and the work on the collisions of α-particles, and there follows a discussion of the periodic table. Next comes the photo-electric effect, and this is followed in due course by Bohr's theory. The lecture ends with a short reference to Born's work on the dynamics of crystals. It is remarkable how large a field the author has managed to cover in so small a space, and the whole is a very good sketch of the present condition of physical theory.

Dr. P. D. Strachan, Serowe, Bechuanaland Protectorate, S. Africa, writes to us stating that in his experience it is necessary to tune the octaves of the upper register of the piano sharp in order that the notes may not sound dull and flat. Professional tuners apparently do the same, giving as their reason that it adds brilliancy to the tone. Dr. R. S. Clay informs us that tuners regularly make the upper eight or ten of a piano a trifle sharp, but there is a difference of a few vibrations only from the true frequency. He suggests that there may be a physiological explanation, or it may be due to the fact that the overtones of the upper notes of a piano are sharp and so produce a desire for corresponding sharpness in notes sounded with them. The effect would become marked with high notes, for the ratio of the restoring force due to the stiffness of the wire becomes progressively important as the length of the vibrating segment becomes shorter. In other instruments, such as the flute, in the use of which Dr. Strachan states he has had a similar experience, it is suggested that the effect may be due to variations in the pitch caused by changes in the method of blowing.

The City Sale and Exchange, of 54 Lime Street, E.C.3, are issuing gratis and post free a catalogue of hand cameras that includes a very large number of items, and apparently every variety of pattern and price. It is gratifying to know that the prices have been very considerably reduced.

Our Astronomical Column.

Total Eclipse of the Sun.—The Lick Observatory has arranged an expedition to Wallal, on the northwest coast of Western Australia, to view the total solar eclipse of September 21. The station offers uniquely favourable meteorological conditions combined with a duration of totality of 5 mins. 18 secs. Various spectroscopic observations will be undertaken, and special cameras are being constructed for investigating the Einstein displacements of the stars. The members of the expedition are Prof. and Mrs. Campbell with Drs. J. H. Moore and R. J. Trumpler (of the Lick Observatory), Prof. A. D. Ross (of the Western Australian Observatory), Dr. and Mrs. Adams (of the Wellington Observatory), and Mr. J. B. O. Hosking (of the Melbourne Observatory). The party will be the guests of the Australian Commonwealth Government during their visit. Wallal will also be occupied by a party organised by Prof. C. A. Chant of Toronto, while Australian expeditions will view the eclipse from Goodiwindi in Queensland and from the north-east corner of South Australia.

Jupiter and his Markings.—Mr. W. F. Denning writes that a number of interesting observations of

features on Jupiter have been obtained recently by Mr. Frank Sargent at the University Observatory, Durham. The Red Spot Hollow was observed in transit across the central meridian on various dates and its longitude determined as follows: 1921, Dec. 12 = 260°·9, Dec. 22 = 259°·7, 1922, Feb. 21 = 257°·4, March 10 = 256°·0, March 31 = 256°·1, April 10 = 254°·2. These positions show a slowly decreasing longitude equivalent to a rotation period of 9 h. 55 m. 38·4 s. This is a decidedly lower rate than the spot exhibited about four years ago when the period was 9 h. 55 m. 34 s. The south tropical disturbance, which is now about 140° long, was central on April 6 in longitude 46° so that it follows the Red Spot Hollow by about 152°. Its rate of rotation during the present year has been about 9 h. 55 m. 32 s. or 6 seconds less than that of the Red Spot Hollow. In 1901 the difference of rotational velocity in the two objects amounted to 22s. but since that time the motions have been gradually approaching uniformity and may possibly in a few years become identical. Mr. Sargent has recently discovered a somewhat abnormal dark marking on the northern edge of the southern equatorial belt, and finds its rotation period to be 9 h. 51 m. 6 s. from 27 rotations performed from March 31 to April 11. He is continuing to follow this and other interesting features with his 10½-inch reflecting telescope.

OBSERVATIONS OF VENUS.—*Pop. Ast.* of March contains a study of this planet by Mr. Alfred Rordame. He has observed it regularly for 20 years with apertures between 4 and 16 inches. In 1921 he took several photographs during daylight with a 9-inch Alvan Clark refractor. Some of these are reproduced, and show some indubitable spots, which are confirmed on more than one negative. Naturally the chief interest concerns the rotation period. He notes that at first he accepted Schiaparelli's value, but now he has come to think that a value near 24 hours is correct. As illustrating the difficulty of the observations, he notes that on less than fifty occasions has he seen definite markings, and on six only has a positive movement of the spots been observed. Some drawings showing this are reproduced. One pair, taken on October 8-9, 1916, tend to confirm De Vico's period of 23 h. 21 m.; Mr. Rordame thinks that those spectroscopic determinations which were made in daylight are liable to error, owing to the blending of the sky spectrum with that of the planet. He considers that the planet is normally covered with dense clouds, the height of which is probably very great.

The same number of *Pop. Ast.* contains a note by Prof. St. John on a photograph of the red end of the spectrum of Venus; the dispersion was so great that the telluric lines would have been separated from those due to Venus's atmosphere by the Doppler effect. No companions, however, were visible to the telluric oxygen bands; it is concluded that oxygen is practically absent from the upper atmosphere of Venus.

SOLAR RESEARCHES.—The February number (vol. 34, No. 197) of the Publications of the Astronomical Society of the Pacific contains several communications on solar work. The first is a general article on the sun by Ferdinand Ellerman. "The Zeeman Effect on the Sun" is the title of the next article by Adrian van Maanen, written and translated from the Dutch journal *Physica*, the October (1921) number of which was dedicated to Dr. Zeeman in recognition of his discovery, 25 years ago, of the separation of spectral lines in a magnetic field. This article is of great interest, summing up the fine work done at Mount Wilson after Hale's important discovery of magnetic fields in sun-spots. Hale himself contributes a note on "Invisible Sun-spots," this term designating the invisible stage of spots which are usually visible during the greater part of their existence. By means of the apparatus which he describes, Hale indicates the importance of making a systematic search for local magnetic fields which may betray the presence of incipient or dying spots. Seth B. Nicholson gives a summary of Mount Wilson magnetic observations of sun-spots for November and December last, and describes the scheme of classification underlying the tables he produces. Systematic observations of the magnetic polarities of sun-spots have been made daily with the 150-foot tower telescope since 1915, and preparations are being made to publish all this valuable new work in detail. Spot groups are divided into three classes and designated unipolar, bipolar, and complex, and some interesting facts about their appearances are given.

PROPOSED 50-FOOT REFLECTOR.—A somewhat wild scheme is said to be contemplated by Prof. Todd and Mr. McAfee. This is the construction of a 50-foot reflector of 1200 feet focus, by utilising a mine-shaft of this depth at Chauaral, Chile, in the Andes, in the locality where Mars will pass exactly overhead at the opposition of 1924. The reflector will consist of rotating mercury, and there must be considerable incredulity about the possibility of keeping this sufficiently free from tremors and eddies to give tolerable definition. The plan ascribed to Prof. Todd is to use a flat, which throws the image into a cave at the side of the shaft, where the camera would be put. But clearly, with such high magnification, the shortest practicable exposure would give a blurred image on a stationary plate. A much better plan would seem to be to put a girder across the mouth of the shaft, carrying a plate-holder or eyepiece which could be moved by clockwork at the appropriate speed (about 1 inch per second). This is known as the Schaeberle method in eclipse photography, and has given satisfactory results. Prof. Todd is well known for bold and striking experiments, and all will wish him well, though without much expectation of success.

A CATALOGUE OF DOUBLE STARS.—A Greenwich volume has lately been published containing the measures of double stars made with the 28-inch refractor between 1893 and 1919. Earlier observations are given for many stars, and in an exhaustive series of notes, mainly by Mr. Jackson, the character of the motion is discussed and the deviations from published orbits indicated. There are also 25 new orbits, computed by him, many of which deviate considerably from earlier determinations. Hypothetical parallaxes are deduced for all stars for which orbit elements are available, and also for other stars which have been observed over an arc sufficiently long to indicate the amount of curvature. The assumed mass of each pair is twice the solar mass; this assumption gives a solar velocity of 19 km./sec., which is in close accord with the spectroscopic value. Comparison of the hypothetical parallaxes with the spectroscopic ones shows perfect accord, in the main, in the case of orbit-stars, but in the arc-stars the hypothetical parallaxes exceed the spectroscopic by 30 per cent.; this is not an excessive error for such small parallaxes (0·07″ to 0·02″). There is some indication of mass varying with spectral type, but this has not been used in obtaining the results.

Research Items.

PREHISTORIC COOKING-PLACES IN NORFOLK.—At the recent annual meeting of the Prehistoric Society of East Anglia, the president, Miss N. Layard, well known for her archæological investigations, particularly in the neighbourhood of Ipswich, delivered an address on prehistoric cooking-places in Norfolk. In the park at Buckenham Tofts, the discovery of what seems to have been a tribal cooking-place was due to rabbits scratching to the surface a number of cracked and fire-marked flints. The term usually applied to such articles is "pot-boilers," but more probably the heated stones were dropped into water-filled troughs made of the skins of large animals, either suspended from poles or used to line pits in the ground. Water and meat are easily boiled in these circumstances by keeping up the supply of heated stones, and the result, as shown by experiments made by the lecturer, was a mixture of charcoal, dirt, and ashes, with well-boiled but discoloured meat.

AN EARLY IRON-AGE VILLAGE NEAR DEVIZES.—In the report of the Marlborough College Natural History Society for 1921, Mrs. Cunnington describes an Early Iron-Age village discovered by chance on All Cannings Cross Farm, about 6 miles east of Devizes. The chief interest and importance of the site lies in the fact that the pottery as a whole seems to belong to the Hallstatt period, and to be throughout of the Hallstatt type. The site seems to have been occupied for a comparatively short and definite period, perhaps for some three centuries. Not a single fragment of anything Roman has been found, so that the occupation seems to have ended well before the Roman conquest, perhaps even some centuries earlier. A full report of the excavations will be found in the *Antiquaries Journal*, January 1922.

MISSIONARIES AS ANTHROPOLOGISTS.—Sir James Frazer in his introductory lecture of a course on the Belief in Immortality and the Worship of the Dead in Polynesia, published in *Science Progress* for April, discusses the general principles of anthropological inquiry, and notes that missionaries, men of education and character, who usually live for years among people of the lower culture, learn their language, and gain their confidence, have special opportunities for observing and recording the habits of savage races. He refers in particular to *Anthropos*, edited by an Austrian priest, Father W. Schmidt, and composed mainly of articles contributed by Catholic missionaries in many parts of the world. "It is much to be desired that the various missionary societies of England would combine to produce a journal of the same scope and the same scientific character. Perhaps, in view of our sectarian differences, that is too much to hope for. But in any case it is highly satisfactory to know that our Protestant missionaries are awakening more and more to the importance of anthropology in the training of missionaries and are taking active steps to remedy what till lately was a most serious defect in their mental equipment."

A HUMAN CRANIUM DREDGED FROM THE RIVER TRENT.—In the March issue of the *Journal of the Royal Anthropological Institute* (vol. li.) Prof. L. Gladstone describes a human cranium which was dredged from the bed of the river Trent, near Hatfield, in 1916. It differs considerably from the average type of skull found in recent and medieval burial-grounds in England, and from the average living types. The circumstances of its discovery indicate that it has affinities with the type of skull found in round barrows associated with bronze implements and pottery of the Beaker class. This race is believed to have made their appearance on our eastern and southern coasts about 2000 B.C., and these large-headed, brachycephalic invaders mingled with the indigenous small and narrow-headed Neolithic population and with subsequent invaders, including the Romans and those from the adjoining European shores. "As a result of inter-marriage of individuals belonging to these races, we find descendants from the original stocks who possess the characters of either one or the other of the ancestral races, in a more or less modified form, or intermediate types." The mid-European or Alpine stock and the broad-headed people of south-west Norway are modern representatives of the Bronze-Age race, modified by intermixture, change of environment and conditions of life, the eating of soft food affecting their jaw form and facial type.

SELF-FERTILISATION IN MOLLUSCA.—In NATURE of January 5, p. 12, Mr. G. C. Robson directed attention to some records of self-fertilisation in Gastropod mollusca and pointed out their importance. Stress was laid in the letter on the desirability of further investigation of this phenomenon. We have lately received an apparently unpublished communication from Mr. S. Manavala Ramanujam, of the Zoological Department, Madras Christian College, in which he describes what appears to be a structural adaptation for self-fertilisation in a family of Pulmonate Gastropoda. In the Vaginulidæ a connection is found between the vas deferens and the receptaculum seminis in the same animal. This connection (the "canalis receptaculo-deferentinus" of Keller) has been described by previous authors (Keller, Pelseneer), but, so far as can be ascertained, without comment. Mr. Ramanujam does not advance any objective evidence that self-fertilisation is effected through this canal, but he is probably right in suggesting that it is used to conduct the animal's own sperm to the receptaculum seminis, if it should fail to receive a supply from another individual. The existence of this connection perhaps indicates that self-fertilisation is of common occurrence in the family.

THE DIRECTION OF THE FIRST MOVEMENT IN AN EARTHQUAKE.—It has been known for some years that the first impulse in an earthquake may appear as a rarefaction at one station and as a condensation at another. Mr. S. Nakamura (*Journ. Meteor. Soc.*, Japan, February 1922) has studied recently several examples of such variations in Japan. In an earthquake at Miyosi (near Hiroshima) the disturbed area was divided into four quadrants by two slightly curved lines. In the south-east quadrant the direction of the first movement was inwards, and in the north-east and south-west quadrants outwards, the remaining quadrant being occupied mostly by the sea. In the Tokio earthquake of December 8, 1921, the distribution was somewhat similar, the curved bounding lines, however, being not quite at right angles; in two opposite regions (north-east and south-west) the movement was inwards, in the other two regions outwards. The great Chinese earthquake of December 16, 1920, seems also to belong to this type, the impulse being outwards in Formosa and inwards in Japan and at Zi-ka-wei. A second type was

illustrated by an earthquake near Oomati (Shinano), in which the first movement was inwards on the south-eastern side of the epicentre and outwards on the north-western side. There appears also to be a third type, though not yet well established, in which the first movement is mainly inwards in all directions from the epicentre.

The Earth's Interior.—The planetesimal hypothesis of the aggregation of the earth is now so justly associated with the name of T. C. Chamberlin that his "Study of fundamental problems of Geology" (Carnegie Institution of Washington, 15th Ann. Rep., p. 412, 1921) has a very wide interest. Continuing his arguments as to the structure and behaviour of a contracting globe formed of solid mineral aggregates, he remarks on the effects of pressure in generating silicates of high density even within the limits of the earth's outer layers. Without actually predicting the occurrence of still denser compounds, formed of familiar types of crustal molecules, towards the earth's interior, he states that "there seems no need to assume the presence of an amount of metal, or other intrinsically heavy material, greater than is implied by the planetary evidence already cited."

Tertiary Fossils of Burma.—Comparative diagnoses of Pleurotomidæ, and of Conidæ and Cancellariidæ from the Tertiary formations of Burma form two consecutive papers by E. Vredenburg in the Records of the Geological Survey of India, vol. 53, 1921, pp. 83-141, illustrated by four excellent photogravure plates by S. C. Mondel. These two papers are in continuation of a previous one on the Terebridæ, by the same author, that appeared in vol. 51, and consist mainly of descriptions of new species. One of these, *Mangilia* [sic] (*Clathurella*) *quinqueangularis*, it is claimed "does not resemble any previously described shell either fossil or recent." To the palæontologist this work will be invaluable, but the systematic conchologist will wish that the writings of later authors than Cossmann, whose big publication Vredenburg has evidently followed, had not been entirely ignored. Both Prof. Dall in America, and Iredale in this country, have advanced our knowledge of these groups since Cossmann dealt with them.

Oil Shale as a Source of Gasoline.—The Journal of the Franklin Institute for March 1922 contains a paper by Prof. R. H. McKee on Gasoline from Oil Shale, in which he outlines the processes of extraction of petroleum from shale, and the possibilities of developing a successful industry in the United States. The text of the paper is not new; as usual, the Scotch Shale Industry is described as a "type," and modifications of method and practice are suggested for the treatment of American raw material. The significance of the paper lies not so much in the principles it seeks to enunciate, but in the warning it contains regarding the gradual decline in production of natural oil in America, and the corresponding need for activity in development of the oil-shale resources of that country. The importation of petroleum from Mexico into the United States, for example, increases annually, in order to help meet the demand both for motor spirit and for petroleum products; as Mexico is regarded by many (and evidently by the author) as a short-lived field, the position in America is likely to become critical within the next decade. Sooner or later a drastic scheme of conservation of the oil resources of the United States for national requirements must eventuate, and before this happens the oil-shale industry and the utilisation of other material as a source of fuel, must be well established in that country. It is well known that there are many technical difficulties arising in connection with the extraction of oil from shale, and that the methods employed in Scotland are not suited to all kinds of shale, especially some of the western American varieties. It is to the solution of these difficulties that American experts are now turning their attention, and research is being assiduously carried on in the Chemical Engineering Department of Columbia University, New York City, under the author's direction, with the view of studying the fundamental factors on which the industry must be based. Similar work is also in progress at the Colorado School of Mines, under the direction of Dr. V. C. Alderson, the well-known authority on oil shale.

Agriculture in India.—The thirty-sixth issue of the Agricultural Statistics of India, for 1919–1920, sets forth most comprehensively the details relative to the position of agricultural affairs. The rainfall on the whole was normal or excessive, no deficit being reported for any area. Following on a marked depression in 1918–1919, the period under review shows a general recovery, though the high-water mark of 1916–1918 was not reached. The area sown was 255 million acres, of which 211 millions were under food crops and 44 millions under others. A considerable increase in the area sown occurred in the North-west and West and in Burma, which more than counterbalanced a drop in the Central Provinces and Bengal. There was less variation in the acreage of rice, cotton, and jute than in other crops, no less than 79 million acres being under rice. While the majority of crops are distributed more or less throughout the country, the larger part of sugar-cane and wheat is grown in the Punjab and United Provinces, tea in Assam, and practically the whole of the jute in Bengal. During the past ten years an increase of 18 millions in livestock has been recorded, due entirely to the larger number of bovine animals reared. In the appendix to the report a useful list of crops is given, with both vernacular and botanical names.

Meteorology in the Netherland Indies.—A general summary of "The Climate of the Netherland Indies" is given by Dr. C. Braak—Verhandelingen, No. 8, vol. i., parts 1 and 2. A short English summary is given with each part. The most prominent feature of the climate is said to be its monotony or its uniformity from day to day, for the moving low-pressure systems common to the higher latitudes which make the weather variable are practically unknown. The most important weather changes are the variations of rainfall, and the monsoons cause a yearly variation in the climate which is rather small in the north but considerable in the south. It is stated that the Malay Archipelago is the most typical monsoon region of the world, the trade-wind systems being disturbed by the influence of the continents of Asia and Australia. Pilot balloon observations at Batavia show that the west monsoon from December to April reaches on an average to a height of 5000 m., whilst from May to October easterly winds blow at all levels up to 7 km. The monsoon wind on high mountain tops is stronger at night than during the day. Near the coast the land and sea breezes are said to have a strong influence. Monthly charts are given of the isobars and winds over the Archipelago which show a complete reversal of meteorological conditions during the year with the change of the monsoon.

Sheep-Breeding and Ancestry.[1]

In the report referred to below, Prof. Ewart first briefly reviews the facts and beliefs about sheep, and, under nine concise statements, summarises our knowledge of the origin and development of present-day types. Much of the work upon which this summary is based is attributable directly to the extensive researches, extending over many years, which Prof. Ewart himself has conducted. In Figs. 1 and 2 the results of these researches are represented diagrammatically.

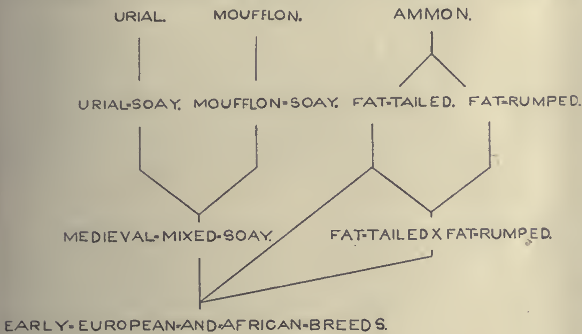

Fig. 1.

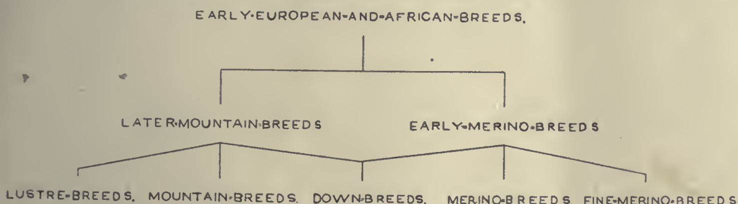

Fig. 2.

From Fig. 1 it will be gathered that the primitive sheep of Europe was of the Soay type, this type having a double ancestry in the Urial or horned sheep and the Moufflon or hornless sheep. Both these types are in evidence to-day in Soay flocks and both are still short-tailed. Nevertheless, both these types cross freely with long-tailed sheep. The modern sheep would seem to have obtained both its tail and its fattening characteristics through the fat-tailed and fat-rumped sheep of Asia. It is further conceivable that the Soay × Fat-tailed or Soay × Fat-rumped sheep followed two lines of migration across Europe—one to the north, coming eventually into the British Isles through the kingdom of Scandinavia, and the other along the shores of the Mediterranean, developing eventually into the Merino sheep of Spain, and in this form taking part in the formation of the British "Down" breeds. In Fig. 2 this latter suggestion is illustrated diagrammatically and the ancestry of present-day sheep indicated.

Fig. 3.

Fig. 4.

There is still a "drift" southwards of sheep from Scotland and a "drift" northwards of sheep from the south of England. It may be that these two drifts are a relic of the drifts of the Nordic and Mediterranean races across the British Isles; but such a theory would need many more facts than are at present available to support it. There is, however, direct support for Prof. Ewart's suggestion respecting our present-day sheep having a fat-tailed ancestor. In Fig. 4 is illustrated the normal head and ears of the Suffolk Down type of sheep. In Fig. 3 is given a photograph of a lamb discovered among a number of this year's Suffolk lambs; and in Fig. 5 an illustration of a sheep with the fat-tailed head. The similarity is very striking. Further, the suggestion that at the base of English Down breed is the Merino is illustrated

Fig. 5.—Head of a 21-days'-old extracted Fat-tail ram lamb. From the *Scottish Journal of Agriculture*. By permission of the Board of Agriculture for Scotland.

in Fig. 4, a Suffolk Down lamb with "crinkled skin"—this crinkled skin being very characteristic of sheep of the Merino type. In further support

[1] Report on Sheep-breeding Experiments. By Prof. J. Cossar Ewart. British Research Association for the Woollen and Worsted Industries, Torridon, Headingley, Leeds.

of the fat-tailed ancestry of present-day sheep, Prof. Ewart noted some time ago a Border-Leicester sheep with the tip of the tail turned up following the lines of the tail of the fat-tailed sheep. Thus it would appear that the nine brief statements with which the report starts are of quite extraordinary interest, and in addition may usefully be kept in mind when studying present-day types of sheep.

Mendelian principles—particularly involving the reshuffling of "characters"—are then insisted on and the value of crosses beyond the first cross emphasised. This is really essential, as so many breeders fail to realise the importance of the F_2 cross. Australian sheep-breeders, however, say "three generations to obtain the cross and thirty to fix it"!

The report is then divided into two sections: (1) experiments with Highland blackface and other modern breeds; and (2) experiments with primitive breeds. It is pleasing to note the assistance accorded by the Duke of Richmond and Gordon and his agent, Mr. R. A. Dawson, Mr. R. Macmillan, Captain J. Stirling, Mr. Dyson Perrin, Sir John Ramsden, Sir Malcolm Macgregor, Mr. Gordon, and the veteran of experimental sheep-breeders, Mr. J. Elwes of Colesborne, Cheltenham.

The Scottish Board of Agriculture is also taking a deep and broad interest in experiments here partially recorded. Ten photographs of typical sheep and their crosses add materially to the value of the report.

The report concludes with references to the experiments in progress under the direction of Prof. White in Wales and to the experiments on British wool characteristics at present being carried out at the University of Leeds. A. F. B.

The Organisation of Knowledge.

CURIOUS reflections on the present state of scientific knowledge are suggested by the extraordinarily interesting address of Dr. F. L. Hoffman to the social and economic science section of the American Association, at the Toronto meeting last December, on "The Organisation of Knowledge," published in *Science* of March 10 and 17. Dr. Hoffman has been for thirty years a very practical organiser of knowledge in connection with his management of the Prudential Insurance Company of America. He has been reading Prof. Whitehead's "The Organisation of Thought," and it seems to have impressed him with a sense of the remoteness of mathematical principles, mathematical methods, and mathematical research from any organisation of science which is serviceable in practical life.

The problem Dr. Hoffman deals with is a profound one, and carries us back to the old distinction between truths of reason and matters of fact which in some form has been the problem of modern philosophy since it first arose with Bacon and Descartes. It is interesting to look back on the confidence with which some of the leaders of philosophic thought in the nineteenth century supposed they had solved it. The confidence appears first in Comte and afterwards in Spencer, who devoted a great part of his intellectual energy to an attempt to give it practical effect. It rested on the idea of a division of labour. It was to be the business of scientific workers to observe and collect facts, guided of course by certain rules of classification and arrangement, but it was to be the special business of philosophers to systematise and generalise. An amusing illustration is a story related to the present writer many years ago by the late Dr. Williamson, professor of chemistry in University College. Herbert Spencer had written to him to ask him whether certain specified chemical experiments could be relied on as correct. In his reply he added to the information asked for his own interpretation, only to receive by return a sharp rebuke pointing out to him that his business was to observe and report facts; it was for the philosopher to theorise concerning them. It is perhaps needless to add that the narrator saw no humour in the story.

The fact gatherer, Dr. Hoffman tells us, should be the fact user. It is the reason he gives for this, however, that deserves particular attention. Fact gathering is impossible without imagination, and imagination is what the mathematician is ever trying to get rid of. The ideal of science is forecasting, and in the business of insurance we have the most complete development of it. In the organisation of knowledge for insurance the whole principle is that all facts are regarded in their interrelation or interdependence for useful purposes. Dr. Hoffman contrasts this with Prof. Whitehead's appeal for a first-hand knowledge which has "never been scared by facts." Progress and discovery depend upon a disciplined imagination, and Dr. Hoffman quotes Karl Pearson, "the man with no imagination may collect facts, he cannot make great discoveries." What we want to forecast are the sort of things mathematics is helpless before, things like the international war, or the influenza epidemic.

Dr. Hoffman concludes his address by outlining the general scheme of his own organisation of the library and information service of his business office.

The Centenary of Naval Engineering.

UNDER this title an interesting paper was read at a meeting of the Newcomen Society on March 30 by Engineer-Commander Edgar C. Smith. Among other matters treated was the development of paddle-wheel vessels, and a notable feature is presented by two tables giving particulars of steam vessels added to H.M. Navy during the period 1820-1850.

During the first twenty years all Navy boilers were of the flue type and were box-shaped. Leakage was very frequent; Dinnen remarks on the numerous "weeps" of which no notice was taken. These boilers were suitable for low pressures only, and it was forty years before the working pressure increased from 3·5 to 20 lb. per sq. in.

Great care was necessary for working these early boilers with salt water. Ships at sea put out the fires every third or fourth day and emptied the boiler. Afterwards, blowing down every two hours became the rule. If the blow-down cocks jammed, the water could be blown through the hand pump, or, according to Murray, "a usual plan is to knock out a rivet from the bottom of the boiler." Feed heating came into use early, an annular tank being placed round the funnel.

The first vessel in the Navy to have a surface condenser was the *Megaera*. She had the five-fold combination of an air-pump, a circulating pump, a surface condenser, an evaporator, and a steam saver. This vessel was wrecked in 1843. The oscillating engine was invented by Murdock, improved by Manby, taken up by Maudslay, and its final success was due to Penn. Since all warships had to retain their sailing qualities, special attention had to be paid to devices for preventing interference from the paddle-wheels whilst the vessel was under sail.

We are indebted to the *Engineer* for the foregoing details, and trust that the author will complete his work by another paper dealing with the development of screw propulsion.

British Research Chemicals.

WE have received a pamphlet entitled "British Research Chemicals produced by Members of the Association," issued by the Association of British Chemical Manufacturers. This is a revised edition of the association's earlier pamphlet, and now contains inorganic as well as organic chemicals. In the list of inorganic chemicals, however, there are many which cannot fairly be called research chemicals, and can be obtained from almost any dealer. These include alum, ammonium chloride, barium chloride, bismuth subnitrate, and the like. It is evident that the Association had research chemicals in mind in drawing up the list, since such substances as ferrous ammonium sulphate are omitted. This inclusion of common chemicals swells the bulk of the list without adding to its value.

Although the preface states that there are certain chemicals on the list a permanent supply of which cannot be guaranteed unless there is sufficient demand (these might have been indicated in some way), it is evident that considerable progress has been made since the issue of the first edition, and the manufacturers are to be congratulated heartily on their efforts to supply from home sources materials which were obtained formerly from abroad. The list is far from complete; the present writer sought in vain for four not very rare substances he requires for research and used to obtain from Germany. With such an excellent beginning, however, the by no means small difficulties of research workers at the present time should rapidly be alleviated.

We notice that the manufacture of new chemicals may be undertaken by one or other of the firms "according to demand." We wish to point out, however, that this will scarcely meet the case satisfactorily. There are some materials which could formerly be obtained from German firms for which the demand must have been extremely small. If the research worker is to be told that the materials he requires cannot be made in this country because there do not happen to be a hundred other people working on the same subject, he will not derive much comfort from the statement. We offer these criticisms in the hope that they may be of assistance, and not in any way as detracting from the praise which is due to the firms for what they have already accomplished.

University and Educational Intelligence.

LEEDS.—At a meeting of the Court of the University of Leeds, held on April 26, it was decided to confer the following honorary degrees among others: *D.Sc.*, Sir Dugald Clerk; Sir Frank Dyson, Astronomer-Royal; Sir Richard Gregory; Sir Charles Sherrington, President of the Royal Society, Waynflete Professor of Physiology in the University of Oxford; and Sir Harold Stiles, President of the Association of Surgeons of Great Britain and Ireland, Professor of Clinical Surgery in the University of Edinburgh. *M.Sc.*, Mr. R. W. Haydon, until recently Lecturer in Agriculture in the University.

A CONFERENCE of representatives of the Universities of the United Kingdom will be held on May 13 in the Botanical Theatre, University College, London. The subjects and the openers of the discussions are as follows: the urgent need for the provision of enlarged opportunities for advanced study and research (Dr. J. C. Irvine); the increase of residential accommodation for undergraduate and other students (Sir Michael E. Sadler); specialisation in certain subjects of study by certain universities (Dr. L. R. Farnell); and the organisation of adult education as an integral part of the work of the universities (Sir. Henry A. Miers).

THE Melbourne correspondent of the *Times* announces that the Universities of Melbourne, Sydney, and Adelaide have agreed to invite Prof. Einstein, when he visits Java, to continue afterwards to Australia and visit the principal cities. Sydney and Melbourne will contribute 80*l.* each towards his expenses, and Adelaide 60*l.*

IT is announced in the *Chemist and Druggist* that under the will of the late Mr. Henry Musgrave sums amounting to 57,000*l.* have been bequeathed to Queen's University, Belfast. The Senate requested the Academic Council to make the consequential regulations for awarding "The Musgrave Research Studentship."

IN a new magazine, *The Beacon*, for April, Mr. E. H. Dance writes on "The Channels of Education: a Suggestion for Remuneration Economy." He admits that economy is as necessary in education as in other national activities, and he remarks that the Scripture lesson is the most unfruitful in the whole curriculum; he also states that the advantages of commandeering a large proportion of the time allotted to it and transferring it to geography would be incalculable. It is suggested that economics might largely take the place of Latin. Science teaching in its present form he condemns because its matter is of little real utility, "even when the canon of utility is educational . . . in spite of recent developments, education continues to lay undue emphasis on deductive reasoning." Science teaching, as now carried out, might, he thinks, be replaced by a more suitable medium: "that medium lies ready to hand in the modern treatment of history. History may be described as the laboratory of politics." "The inculcation of a general æsthetic sense is perhaps the most obvious need of modern education." Some of us may find it difficult to accept the writer's conclusions, but the article is well written and suggestive.

IN the course of his presidential address, delivered on April 20 at the annual general meeting of the Institution of Mining and Metallurgy, Mr. S. J. Speak referred to the part which the Institution has played in the development of technical education. Speaking of the Imperial College of Science and Technology, London, and particularly of the Royal School of Mines, he said that the Institution had aimed always at securing recognition for the College as "the technological centre of the Empire." The work of the College was, however, hampered seriously by lack of the power to grant degrees, and for this reason it is advocated that the status of the College should be raised to that of an Imperial University of Science and Technology. Opposition to this suggestion comes mainly from two sources: first, from the University of London, which naturally desires to absorb vigorous local institutions into itself and fails to see that facilities for obtaining London degrees do not meet the case. The second source of opposition is found in those educated on the classical side of existing universities, and to them a University of Science and Technology is unthinkable. Mr. Speak protested against this as suggesting that the study of the "humanities" is a higher form of education than the study of science.

Calendar of Industrial Pioneers.

May 4, 1879. William Froude died.—" The greatest of experimenters and investigators in hydrodynamics," Froude began his researches on the motion of ships among waves in 1856. They were made at the request of I. K. Brunel, who was then engaged with the building of the *Great Eastern*. Froude had been employed under Brunel on the Great Western Railway. His work led to the construction by the Admiralty of the experimental tank at Torquay, the first of its kind ever built. He carried out experiments on the effects of bilge keels and on the resistance and propulsion of ships, and he is also known as the inventor of a dynamometer.

May 4, 1886. James Muspratt died.—After an adventurous youth, a part of which was spent in the Navy, Muspratt settled in Liverpool and began the manufacture of soda according to the Leblanc process. Six years later he was joined by Gamble and new works were erected at St. Helens. Afterwards he had works at Widnes and Flint. He has been called the father of the alkali trade in Lancashire. He was a great friend of Liebig.

May 4, 1908. Gustav Friedrich Herman Wedding died.—A distinguished writer on metallurgy, Wedding studied at the Mining Academies of Berlin and Freiburg and ultimately became professor of metallurgy at the Technical High School at Charlottenburg. His works were regarded as of exceptional value and in 1896 he was awarded the Bessemer Medal of the Iron and Steel Institute.

May 5, 1909. Bindon Blood Stoney died.—For many years chief engineer to the Dublin port authority, Stoney attracted attention by his use of huge concrete monoliths of 350 tons weight. He made an elaborate study of stresses in girders, contributed many papers to the scientific societies, and in 1871 was president of the Institution of Civil Engineers of Ireland.

May 6, 1897. Jedediah Strutt died.—A Derbyshire farmer, Strutt in 1758 and 1759, with his brother-in-law, took out successful patents in connection with stocking machines. He also suggested improvements in the spinning frame of Arkwright.

May 7, 1890. James Nasmyth died.—An eminent mechanical engineer and inventor, Nasmyth in 1829 became the personal assistant of Henry Maudslay, and four years later set up in Manchester as a maker of machine tools. To him we owe the steam hammer, the steam pile driver, the nut making machine, a hydraulic punching machine, and the coiled spiral wire flexible shaft now so largely used.

May 8, 1916. John Edson Sweet died.—The recipient of the John Fritz medal for his " achievements in machine design, and pioneer work in applying sound engineering principles to the construction and development of the high-speed steam engine," Sweet was at one time professor of mechanical engineering in Cornell University. To him was due the initial step leading to the founding of the American Society of Mechanical Engineers, of which he became the third president.

May 9, 1914. Paul Hérault died.—Born in 1862, Hérault studied at the Paris School of Mines and at the age of twenty-four brought out his electrolytic process for the production of aluminium, a discovery made independently in America by C. M. Hall (1863–1914).

May 10, 1864. Alphone René le Mire de Normandy died.—A pioneer in the modern practice of distilling fresh water from salt water, Normandy brought out his invention in 1851. A native of France, he became a practical chemist and settled in England in 1843.

E. C. S.

Societies and Academies.

LONDON.

Geological Society, April 12.—Prof. A. C. Seward, president.—F. W. **Edwards**: Oligocene mosquitoes in the British Museum, with a summary of our present knowledge concerning fossil Culicidae. All the specimens are from the Oligocene of the Isle of Wight. The genera appear to be inseparable from those of the present day, and some of the species suggest a fauna similar to that of Ethiopian and Oriental regions. No peculiar forms occur. The genus Anopheles has not been found, probably because of its comparative rarity. Three species from the Oligocene of the Isle of Wight, described by Prof. Cockerell, are referred to the genus Aedes; and two new species, one of Culex and one of Tæniorhynchus, are described. No fossil that can be positively referred to the Culicidæ is yet known from the Mesozoic.—A. C. **Seward**: On a collection of Carboniferous plants from Peru. The plants described were collected by Mr. J. A. Douglas in 1911 from coal-bearing strata on the south side of the Peninsula of Paracas, a few miles south of Pisco on the coast of Peru. They are mostly fragmentary; whether they are of an Upper or a Lower horizon is not certain. Hitherto no fossiliferous Palæozoic rocks have been recorded from the Peruvian coast.—Miss M. E. J. **Chandler**: The geological history of the genus Stratiotes: an account of the evolutionary changes which have occurred within the genus during the Tertiary and Quaternary eras. Stratiotes, a monotypic genus of European and West Asian water-plants, can be traced back to the Eocene. The recent seed was described and an account given of the modifications which have occurred in the genus since the Eocene period. Of nine species described, *S. aloides* alone is still living. Seven appear to be direct ancestors of the recent plant, while two perhaps represent a branch-line of evolution. The fossil species occur in great abundance, are widespread geographically, and each seems to have a limited range in time. They may therefore serve to correlate isolated freshwater deposits in Europe.

Royal Meteorological Society, April 19.—Dr. C. Chree, president, in the chair.—W. T. **Russell**: The relationship between rainfall and temperature as shown by the correlation coefficient. The temperature of any two successive months over a series of years is correlated to the extent of approximately $+0{\cdot}3$. Since the mean monthly temperatures for the twelve calendar months follow very closely a sine curve, the coefficient of correlation should be unity. Rainfall in alternate months shows some high correlation coefficients, *e.g.* the coefficient between the rainfall in June and August in London is $+0{\cdot}55$. There is a negative correlation of $0{\cdot}5$ between rainfall and temperature in the same month in summer—evidence of the effect of solar radiation—while positive coefficients are found for the winter months. The change is attributed to the influence of the ocean in maintaining a temperature in excess of that due to latitude and season.—R. A. **Fisher** and Winifred A. **Mackenzie**: The correlation of weekly rainfall. The weekly rainfall for the past forty years at York, Aberdeen, and Rothamsted has been examined with a view of exploring the main features of weather localisation. Probably simple laws connect these quantities over considerable areas, which will give an idea of the accuracy of meteorological estimates based on a limited number of stations. A well-marked annual periodicity in the rainfall correlations rises relatively slowly in the autumn, and the autumn

values commonly remain for about three months close to the mean value for the year.—S. **Chapman** and Miss E. **Falshaw**: The lunar atmospheric tide at Aberdeen, 1869–1919. Methods similar to those formerly employed for the Greenwich records were used. The phases of the tide at the two stations agree as well as can be expected considering that Aberdeen is more disturbed, and the amplitude appears to be slightly greater at Aberdeen than at Greenwich.

PARIS.

Academy of Sciences, April 3.—M. Emile Bertin in the chair.—The president announced the death of Prof. Ph. A. Guye, correspondent of the Academy for the section of chemistry.—A. **Lacroix**: A syenite containing corundum and sillimanite formed by endomorphism of granite.—M. **Hamy**: The determination of the diameter of stars by the interference method. The telescope objective is covered by a screen carrying two narrow slits, and if the latter are sufficiently near, Young's fringes are seen. When the distance between the slits increases, the fringes diminish in clearness and vanish at a distance which is a function of the diameter of the star. The formulæ for the determination of the star diameter are given, and the numerical constants worked out.—C. **Moureu** and A. **Lepape**: The estimation of krypton and xenon in absolute value by spectrophotometry. A simplification of the method described in 1911. Standard mixtures of pure krypton and xenon in argon have been prepared and the pressure determined, in the Plücker tube, at which the intensity of a given krypton (or xenon) line is equal to that of a fixed argon line. These pressures and proportions are given in two tables.—F. **Mesnil** and M. **Caullery**: The maxillary apparatus of *Histriobdella homari*; the affinities of the Histriobdellæ with the Eunicians.—M. René Baire was elected correspondent for the section of geometry in the place of the late M. Nœther.—N. E. **Nörlund**: The interpolation formula of Stirling.—B. **Gambier**: Isothermal surfaces with spherical isothermal representation.—J. **Le Roux**: The curvature of space.—S. **Millot**: Calculating balances. A plate oscillating on two knife edges and having various scales ruled on it perpendicular to the axis of oscillation can be used as a generalised calculating machine. A practical example of its use in a complicated calculation is given.—G. **Rémoundos**: Plane deformations and the problem of the thrust of earth.—M. **Frontard**: Law of the dangerous height of clay cuttings.—A. **Perot**: The measurement of pressure in the atmosphere of the sun. The method is based on the variation with pressure of the ratio of the wave lengths of two lines of the spectrum, the coefficients of variation with pressure of which are different. The present data are based on five iron lines and give a mean pressure of 34 cm. of mercury, or just under half an atmosphere.—J. **Mascart**: Observations of the partial eclipse of the sun of March 28, 1922, made at the Lyons Observatory (Saint-Genis-Laval). Observations of the times of contacts by six observers are given, and these differ appreciably from the calculated times given in the *Connaissance des Temps*.—E. **Esclangon**: Observations of the eclipse of the sun of March 28, 1922, made at the Observatory of Strasbourg.—T. **Moreux**: Observations of the eclipse of the sun of March 28, 1922. Observations made at Bourges under unfavourable conditions.—G. **Bruhat** and A. **Delaygue**: Determination of the upper point of inversion of the specific heat of the saturated vapour of benzine.—M. **de Broglie**: The corpuscular spectra of the elements. A continuation of previous researches carried out with larger apparatus. Reproductions are given of the spectra obtained with silver, tin, gold, and uranium.—C. **Gutton**: The simultaneous maintenance of an oscillating circuit and harmonic circuits.—P. **Job**: The hydrolysis of the roseocobaltic salts.—A. **Wahl**, G. **Normand**, and G. **Vermeylen**: The monochlortoluenes. Pure ortho- and para-monochlortoluenes were prepared and the melting point curve for mixtures of the two constructed. This curve can be used in the analysis of mixtures. In the chlorination of toluene, a new catalytic effect of lead chloride is noted, which has a bearing on the industrial preparation of benzyl chloride.—Mlle. G. **Cousin**: Tectonic observations of the secondary strata of the southern border of the Vosges.—L. **Dangeard** and Y. **Milon**: Contribution to the study of the Tertiary basin to the south of Rennes. Discovery of beds containing fishes and plants in the black clays at the summit of the Chattian.—P. **Bugnon**: The hypocotyl of the Mercurialis.—H. **Jumelle**: A great palm tree from the centre of Madagascar.—A. **Policard** and Juliana **Tritchkovitch**: The mechanism intervening in the fixation of fats by the cortico-suprarenal gland.—P. **Lecompte du Noüy**: The superficial equilibrium of the serum and of some colloidal solutions. A description of a new apparatus for studying the continuous variation of the surface tension of a liquid. With this it has been shown that, at constant temperature, the surface tension of solutions of sodium oleate, glycocholate and taurocholate, of saponin and of blood serum diminishes spontaneously with time, rapidly during the first ten minutes then more slowly, the results being expressed by an exponential curve.—E. **Roubaud**: The winter hibernation in the larvæ and nymphs of the flies.—E. **Grynfeltt**: The perforating fibres of the bone of mammals.—P. **Bouin**: The parallel conjugation of the chromosomes and the mechanism of the chromatic reduction.—H. **Bierry**, F. **Rathery**, and F. **Bordet**: Experimental azotemia and hyperproteidoglycemia.—E. **Burnet**: A type of arthritis frequently observed in guinea-pigs infected with *Micrococcus melitensis*.

CAPE TOWN.

Royal Society of South Africa, March 15.—Dr. J. D. F. Gilchrist, president, in the chair.—B. de C. **Marchand** and B. J. **Smit**: The soils of the Hartebeestpoort irrigation area (Pretoria and Rustenburg districts).—H. E. **Penrose**: The trend of radio-development. The various methods adopted for wireless transmission were described and compared with the three electrode thermionic valve method. The possibilities of transmitting a beam of wireless waves in any given direction and direction finding were also discussed.—W. S. H. **Cleghorne**: A study in charcoal: being a research on charcoals made from exotic woods grown in the Union of South Africa. Charcoals were classified by the following methods: (*a*) proximate analysis; (*b*) measurement of the fuel consumption per brake horse-power on suction gas engine trial at constant given load for six hours' run; (*c*) analysis of the gas from the gas producer while the engine was on the trial; (*d*) measurement of the weight of a given volume of charcoal. Charcoal from *Acacia saligna*, the common Port Jackson Wattle of the Cape Flats, gave excellent results.—F. G. **Cawston**: Some notes on the differentiation of closely-allied Schistosomes. Fresh-water snails are infested occasionally with the cercariæ of more than one species of trematode. There are conditions under which schistosomes may develop in other than their common intermediary host. A determination of the number of pairs of mucin glands is one of the best means of determining the species to which a cercaria belongs.

Official Publications Received.

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 11, No. 4: Studies in Gujurat Cottons. By Maganlal L. Patel. Part 1. Pp. ii+75-127+8 plates. 2 rupees; 2s. 6d. Botanical Series, Vol. 11, No. 6: The Influence of Atmospheric Conditions upon the Germination of Indian Barley. By W. Youngman. Pp. 145-151. 9 annas; 1s. (Calcutta: Thacker, Spink & Co.; London: W. Thacker & Co.)

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1921. Pp. ii+12. (Cape Town: Cape Times, Ltd.)

Société française de Physique. Procès-Verbaux et Résumé des communications faites pendant l'année 1921. Pp. 112. (Paris: Gauthier-Villars et Cie.)

Third Annual Report of the Governors of the Imperial Mineral Resources Bureau. Pp. 72. (London: The Bureau, 2 Queen Anne's Gate Buildings.)

Università degli Studi di Perugia. Annali della Facoltà di Medicina e Chirurgia (Organo Ufficiale dell' Accademia Medico-Chirurgica di Perugia). Vol. 26, Serie V. Pp. 302. (Perugia: G. Guerra.)

Papers and Proceedings of the Royal Society of Tasmania for the Year 1921. Pp. iv+222+30 plates. (Hobart: Tasmanian Museum.) 10s.

Transactions and Proceedings of the Royal Society of South Australia. Edited by Prof. W. Howchin. Vol. 45. Pp. vii+316+22 plates. (Adelaide: Royal Society of South Australia.) 9s.

Diary of Societies.

FRIDAY, May 5.

Iron and Steel Institute (at Institution of Civil Engineers), at 10.30 a.m.—D. Selby-Bigge: Recent Developments in Power Production.—A. Westgren and G. Phragmen: X-ray Studies on the Crystal Structure of Steel.—N. T. Belaiew: The Inner Structure of the Pearlite Grain.—J. H. Whiteley: Formation of Globular Pearlite.—A. F. Hallimond: Delayed Crystallisation in the Carbon Steels: the Formation of Pearlite, Troostite, and Martensite.—K. Honda: The Constitutional Diagram of the Iron-Carbon System, based on Recent Investigations.—K. Honda and T. Kikuta: The Stepped A1 Transformation in Carbon Steel during Rapid Cooling.—N. Yamada: The Heat of Transformation of Austenite to Martensite, and of Martensite to Pearlite.

Royal Society of Medicine (Laryngology Section), at 3.—Annual General Meeting and Special Clinical Meeting.

Royal Society of Arts (Dominions and Colonies and Indian Sections), at 4.30.—Prof. W. H. Eccles: Imperial Wireless Communication.

Royal Astronomical Society (Geophysical Discussion), at 5.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of Museum Specimens illustrating Umbilical and Diaphragmatic Hernia.

Institution of Electrical Engineers (London Students' Section), at 7.—R. P. Howgrave-Graham: Electrically Oscillatory Discharges.

Institution of Mechanical Engineers (Informal Meeting), at 7.—Failures.

Junior Institution of Engineers, at 8.—E. N. Ching: Casting under Steam Pressure.

Royal Institution of Great Britain, at 9.—Dr. M. Grabham: Biological Studies in Madeira

SATURDAY, May 6.

Association of Engineers-in-Chief (at St. Bride's Institute), at 7.30.—Discussion on Uniflow *v.* Multiple-Expansion Steam Engines.

MONDAY, May 8.

Royal Institution of Great Britain, at 5.—General Meeting.

Royal College of Surgeons of England, at 5.—Prof. Shattock: Demonstration of Museum Specimens illustrating Tuberculosis.

Royal Society of Medicine (War Section), at 5.30.—Annual General Meeting.

Royal Society of Arts, at 8.—F. F. Renwick: Modern Aspects of Photography (2) (Cobb Lectures).

Surveyors' Institution, at 8.—R. Cobb: Agricultural Valuations.

Royal Geographical Society (at Æolian Hall, 135 New Bond Street, W.1), at 8.30.—R. Bryce: The Klagenfurt Plebiscite.

Medical Society of London, at 9.—H. J. Waring: Annual Oration.

TUESDAY, May 9.

Royal Institution of Great Britain, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire. Series II. Racial Problems of Africa (3).

Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.—E. H. Cunningham Craig: The Oil Shale of Esthonia.

Zoological Society of London, at 5.30.

Royal Society of Medicine (Psychiatry Section), at 5.30.—Annual General Meeting.

Quekett Microscopical Club, at 7.30.—E. Cuzner: A Short Account of some Varieties of Marine Zoology.

Royal Photographic Society of Great Britain (at Royal Society of Arts), at 8.—Prof. The. Svedberg: The Interpretation of Light Sensitivity in Photography (Hunter and Driffield Memorial Lecture).

Royal Anthropological Institute, at 8.15.—Capt. M. W. Hilton Simpson: Some Ethnographical Researches among the Berbers of Algeria.

WEDNESDAY, May 10.

Royal College of Surgeons of England, at 5.—Prof. H. Burrows: The Results and Treatment of Gunshot Wounds of the Blood Vessels (1) (Hunterian Lectures).

Geological Society of London, at 5.30.—Prof. E. J. Garwood and Miss E. Goodyear: The Lower Carboniferous Succession in the Settle District and along the Line of the Craven Faults.—E. J. Wayland and Dr. A. Morley Davies: The Miocene of Ceylon.

Royal Society of Medicine (Surgery: Sub-section of Proctology), at 5.30.—Annual General Meeting.

Royal Society of Arts, at 8.—Major P. A. MacMahon: The Design of Repeating Patterns for Decorative Work.

Institution of Automobile Engineers (at Institution of Mechanical Engineers), at 8.—J. Watt: Automobile Calculations: Practical Methods for the Designer.

THURSDAY, May 11.

Royal Institution of Great Britain, at 3.—Prof. F. Keeble: Plant Sensitiveness. I. To Light.

Royal Society, at 4.—Election of Fellows, 4.30.—*Probable Papers.*—Lord Rayleigh: A Photographic Spectrum of the Aurora of May 13-15, 1921, and Laboratory Studies in connection with it.—Lord Rayleigh: A Study of the Presence or Absence of Nitrogen Bands in the Auroral Spectrum.—Dr. C. Chree: The 27-day Period (Interval) in Terrestrial Magnetism.—M. Barker: The Use of very small Pitot-tubes for measuring Wind Velocity.—E. T. Paris: Doubly-resonated Hot-wire Microphones.—Prof. J. C. McLennan and D. S. Ainslie: The Structure of the Line of Wavelength $\lambda=6708$ Å.U. of the Isotopes of Lithium.

Royal College of Surgeons of England, at 5.—Prof. H. Burrows: The Results and Treatment of Gunshot Wounds of the Blood Vessels (2) (Hunterian Lectures).

London Mathematical Society (at Royal Astronomical Society), at 5.—Prof. G. H. Hardy: The Elements of the Analytic Theory of Numbers (Lecture).—L. J. Mordell: The Integral Solutions of the Equation $y^2=ax^3+bx^2+cx+d$.—W. P. Milne: Sextactic Cones and Tritangent Planes of the same System of a Quadri-cubic Curve.—A. C. Dixon: An Integral Equation.—E. L. Ince: On Harmonic Equations and in particular the Equations associated with Parabolic and Circular Boundary Problems.

Optical Society (at Imperial College of Science and Technology), at 7.30.—Discussion on Motorcar Head-lights.

Royal Society of Medicine (Neurology Section), at 8.30.—Annual General Meeting.—Dr. E. Bramwell: Some Features of Myopathy.

FRIDAY, May 12.

Royal Astronomical Society, at 5.

Physical Society of London (at Imperial College of Science and Technology), at 5.

Royal Society of Medicine Clinical Section), at 5.30.—Annual General Meeting.

Malacological Society of London (at Linnean Society).

Royal Institution of Great Britain, at 9.—Dr. H. H. Dale: The Search for Specific Remedies.

SATURDAY, May 13.

Royal Institution of Great Britain, at 3.—Prof. O. W. Richardson: The Disappearing Gap between the X-ray and Ultra-violet Spectra. I. Grating Results.

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

FRIDAY, May 5.

University College, at 5.—Prof. T. Borenius: The Re-discovery of the Primitives (Admission by Invitation only);—at 5.30.—Prof. W. R. Shepherd: The Expansion of European Civilisation (1).

King's College, at 5.30.—Dr. J. Hjort: Biological Aspects of Oceanography (4).—R. F. Young: The University of Prague.

TUESDAY, May 9.

University College, at 5.—Sir Arthur Shipley: Insects and Disease (2).

King's College, at 5.30.—Prof. H. Wildon Carr: The Principle and Method of Hegel (2). The Dialectic.

Gresham College, at 6.—A. R. Hinks: Astronomy (1) (Gresham Lectures).

WEDNESDAY, May 10.

University College, at 5.15.—Dr. D. H. Scott: The Early History of the Land Flora (3).

Gresham College, at 6.—A. R. Hinks: Astronomy (2) (Gresham Lectures).

THURSDAY, May 11.

St. Mary's Hospital (Institute of Pathology and Research), at 5.—Prof. G. Elliot Smith: The Anatomy of Anxiety.

Royal Society of Arts, at 5.15.—Sir Lawrence Weaver: Rural Re-Settlement and its Relation to Public Health (2) (Chadwick Lectures).

University College, at 5.15.—Sir Joseph J. Thomson: Atoms, Molecules, and Chemistry (2);—at 5.30.—H. E. Goad: Nature in Glosue Carducci's Poems.

Birkbeck College, at 5.30.—Prof. J. C. Schoute: Whorled Phyllotaxis.

Gresham College, at 6.—A. R. Hinks: Astronomy (3) (Gresham Lectures).

FRIDAY, May 12.

London School of Economics, at 5.—Dr. P. Giles: Modern Views of Indo-European Origins (1).

University College, at 5.15.—A. E. M. van der Meersch: Simplified Solutions for B.M. and S.F. Values for Rolling Loads (1);—at 5.30.—Prof. W. R. Shepherd: The Expansion of European Civilisation (2).

Birkbeck College, at 6.—Dr. E. J. Russell: Recent Work with regard to the Influence of Soil Conditions on Agriculture (1).

Gresham College, at 6.—A. R. Hinks: Astronomy (4) (Gresham Lectures).

SATURDAY, MAY 13, 1922.

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Contemporary Alchemy.

IN another part of this issue we print the concluding part of Sir Ernest Rutherford's account of his researches on the disintegration of the atoms of some elements by means of α-rays. The theory of atomic structure which postulates a small positive nucleus and sparsely distributed surrounding electrons indicates that a permanent change in the atom requires the disruption of the nucleus itself. This nucleus is also, according to modern views, an association of simpler parts, probably only units of positive and of negative electricity, which are the same in all atoms. If this arrangement can be altered, we should change one atom into another, or others. The forces binding the components of the nuclei of stable atoms must be very great, and in overcoming them a large expenditure of energy will be required. The swift α-particle expelled from radium is by far the most concentrated source of energy known, and by firing these α-particles through matter, collisions with the atomic nuclei might be expected to break up the latter.

This is the idea on which the work is based, and it has now, as Sir Ernest explains, received remarkable experimental confirmation. He found that, with nitrogen gas, hydrogen atoms were liberated, but these did not appear with oxygen or carbon dioxide. Such particles are, of course, produced in hydrogen gas, or substances containing hydrogen, but simple precautions ensure that the hydrogen particles otherwise observed do not come from hydrogen existing as an impurity in the materials. The H-particles from hydrogen have a range in air of 30 cm., and by interposing mica screens equivalent to this absorption, no such particles are observed as scintillations on a zinc sulphide screen. With nitrogen interposed between the source of α-rays and the mica screen, however, numerous scintillations appear.

By placing a thin film of metal over the source of α-rays, and having oxygen between this and the screen, the production of H-particles from metals could be investigated. Solid compounds were dusted over gold foil, which itself gives no H-particles.

With the exception of helium, neon, and argon, all the elements up to atomic weight 40 were examined. In no cases except boron, nitrogen, fluorine, sodium, aluminium, and phosphorus were any H-particles observed. No element of atomic weight greater than phosphorus (31) gave any effect, but only particles of range not less than 32 cm. were sought.

A very striking result was observed in the case of aluminium, since nearly as many H-particles were shot off in the backward as in the forward direction of the

colliding α-particles. This is explained by assuming that the H-particle in the aluminium atom is describing an orbit around the nucleus, when the direction of escape would depend on the relative positions of the α-particle and nucleus at the moment of collision with the satellite.

In the case of aluminium the maximum energy of the H-particle is 1·4 times that of the incident α-particle, and part of the energy must, therefore, have been derived from the nucleus itself. The disintegration is effected on an extremely minute scale; only about two α-particles in every million get near enough to the inner nucleus to dislodge an H-particle. If all the α-particles from 1 gram of radium were fired into aluminium, only one-thousandth of a cubic millimetre of hydrogen could be liberated in one year.

It has been surmised that the α-particle, or helium nucleus, of mass 4, is one of the units of which atoms are built up. The experiments referred to show that the hydrogen nucleus is also one of the units of structure, at least of some of the lighter elements. H-particles are only liberated from elements of atomic masses $4n+2$ or $4n+3$, where n is a whole number. Elements like oxygen and carbon, the atomic masses of which are $4n$, give no H-particles. This result would follow if the nuclei of the former elements are built up of helium nuclei, of mass 4, and hydrogen nuclei as satellites. The mass of the latter should not differ much from the free H-nucleus of mass 1·0077 in terms o=16, on account of the weaker binding of the satellite to the nucleus. If the nitrogen nucleus is made up of three helium nuclei of mass 12 and two hydrogen nuclei, the mass of the nitrogen atom should not be 14·00 but more nearly 14·01, as found by chemical methods. In the case of light elements the effective masses of the hydrogen nuclei should vary from 1·007 to 1·000 in different atoms, depending on the closeness of combination.

In earlier experiments particles of mass 3 with two positive charges appeared to have been liberated from oxygen and nitrogen. These, however, are now known to have their origin, at least in the case of oxygen, in the radioactive source and not in the volume of the gas.

We think it no exaggeration to say that these experiments are some of the most fundamental which have ever been made. It is not often that a scientific discovery excites interest outside the narrow circle of the laboratory or the scientific lecture-room. The discovery of radium by the Curies appealed to the larger world with a force which was equalled only by the profound interest aroused by the discovery of phosphorus by Brand in 1669, and of potassium by Davy in 1807, and so fundamental are the consequences of this new discovery that the intellectual world at large must follow with the keenest interest the progress of the experiments associated with the name of Rutherford. It was soon evident that increasing knowledge of the properties of radioactive substances was bound to alter fundamentally some of the cherished conceptions of the ancient science of chemistry. Sir William Ramsay held very tenaciously to the view that the immensely concentrated energy of the α-particle offered a means of testing that apparent simplicity of the chemical elements which they had succeeded in preserving, in trying circumstances, since the time of the alchemists. His experiments, however, could not at the time be convincing.

When Sir Ernest Rutherford went to Cambridge he had already made some progress in the most difficult task he has yet attempted. The means he used appear simple, as he describes them, but the experimental skill which was required to achieve these results is of a very high order. We feel sure that all our readers will join us in congratulating him on the work he is doing, and in expressing the hope that his further researches will continue to add to the splendid harvest of positive knowledge which is so rapidly growing under his hand.

It is obvious that the results so far achieved in this region are but the beginnings. There are many things we need to know, and some of the yet unsolved problems which suggest themselves may soon be cleared up by further researches. The chemist will be curious to know what is left when hydrogen is expelled from nitrogen, boron, aluminium, or other atoms. If boron is a mixture of two isotopes, of masses 10 and 11, these will be of the forms $4n+2$ and $4n+3$, both of which should give H-particles, as is found to be the case; but if lithium is a mixture of isotopes of 6 and 7, these ought also to give H-particles, although they were not detected under the conditions of experiment. If chlorine is a mixture of two isotopes, 35 and 37, the first is of the form $4n+3$, which should give H-particles, and the second of the form $4n+1$, which is not referred to by Sir Ernest Rutherford. Apparently, no H-particles were expelled from chlorine. This element, however, has an atomic mass higher than the limiting value 31, beyond which no H-particles were in any case found.

It may be that there is some change in the mode of building up the nucleus at this point, or, what seems more likely, that H-particles are, in fact, expelled, but are of such a range and velocity that they could not be detected in the present experiments. These difficulties will no doubt soon be cleared up, and we must await with such patience as we can the continuation of Sir Ernest Rutherford's work.

A History of Chemistry.

Die geschichtliche Entwicklung der Chemie. Von Dr. Eduard Färber. Pp. xii+312+4 plates. (Berlin: Julius Springer, 1921.) U.K., 312 marks; Germany, 78 marks.

DR. EDUARD FÄRBER'S "Historical Development of Chemistry" is one of those books that owe their existence to other books. It has been put together mainly with the aid of older works, more or less authoritative, on the subject of which it treats. As one turns over its pages, it is not difficult to trace the source of most of its statements. With the possible exception of the concluding section, which is concerned with the history of the present epoch, there is little evidence of original inquiry to be seen anywhere. Kopp and Lippmann have been drawn upon freely for the story of the rise and development of the chemical arts until the inception of phlogistonism, and Hoefer and Ostwald's "Klassiker," and Ostwald's "Lehrbuch der allgemeinen Chemie" have together furnished most of the material for the story up to the Revolution accomplished by Lavoisier and his co-workers. Much relating to the subsequent period has been gleaned from Kahlbaum's "Monographien," and from Hjelte's and Graebe's admirable histories of organic chemistry. For so much of the history of the progress of chemistry during what we may term our own epoch which has not yet been included in any systematic historical work, Dr. Färber has necessarily been driven for his information to special treatises, periodicals, and the published transactions and journals of the recognised chemical societies. To this extent he has certainly striven to exercise an independent judgment.

The works the author has consulted are excellent in their several ways, but it is well known to historiographers that much additional information has come to light on subjects which seemed adequately treated when certain of these works appeared. This is especially true of the earliest periods of chemical development. The researches of Egyptologists, for example, and the recent publication of works relating to Hindu and Chinese chemistry have made known many important facts concerning primitive operative processes essentially chemical in their nature. Manuscripts relating to later times have been discovered of which the existence was unsuspected. The real nature of others already known had not been revealed or was imperfectly understood. A more critical examination of ancient treatises has afforded new interpretations of what was obscure. Kopp's "Geschichte," published in 1843, when its author was barely of age, admirable as it is in many respects, has no longer the authority it enjoyed half a century ago. The "Beiträge," which appeared between 1869 and 1875, and the two volumes on "Die Alchemie in älterer und neuerer Zeit," based upon a fuller study of certain periods, no doubt supplemented and amplified the history. The "Entwicklung der Chemie in der neueren Zeit," printed and published in 1873 under the auspices of the Historical Commission of the Bavarian Academy, is but a fragment. It was written at a time of rapid change when Kopp was nearing the allotted span, and when his association with organic chemistry, never very intimate, was but slight. His editorial connection with Liebig's *Annalen* was probably the main source of his inspiration; certainly the Heidelberg atmosphere at that period had no quickening influence. Presumably Dr. Färber has been in a position to make use of this supplementary work. In any case, what is of permanent value in it has been incorporated in such later histories as that of Ernst von Meyer and of Ladenburg, but our author makes no mention of this additional matter.

It must be admitted that much of the information needed in the preparation of a history of chemistry that will comply with modern standards of historical research is not readily accessible. Some of it is scattered through publications comparatively unknown to the average professional chemist, as they seldom find their way into the ordinary chemical library. But some of this information has appeared in book form and is easily available, as, for example, Berthelot's "Les Origines d'Alchemie" and Roscoe and Harden's "New View of the Origin of Dalton's Atomic Theory," both of which works would seem to have escaped the author's notice.

Although the work is obviously a compilation—and it is but just to the author to state that he freely acknowledges his obligations by his abundant references to the sources of his statements—we by no means would imply that it is without merit. On the contrary, the general reader who is desirous of learning something of the rise and development of chemical science will find it of great interest, and most professed chemical students would widen their horizon considerably by an attentive perusal of its contents. It is written absolutely without bias and with an evident desire to present a well-proportioned and reasonably adequate account of the rise and progress of the science over the periods which the authors to whom the writer is mainly indebted have already traversed.

Considering that the book is intended for general reading, we venture to suggest that it would have added to its attractiveness if it were more freely illustrated. The interest of history is largely personal. The ordinary reader desires to know what manner of men they were who have collected the facts

of chemistry, and formulated its theories. He wishes to learn something of their characteristics, where and how they laboured, and what were the conditions and circumstances under which their discoveries were made. This no doubt would have involved search, wide reading, insight, and power of characterisation, but it would have added greatly to the human interest of the work, and have imparted vitality and colour to what we are constrained to say is a rather bald and impassive story of human achievement.

The author attempts in some degree to meet what we suggest by reproducing a copy of a print belonging to the National Germanic Museum at Nuremberg representing an "Alchemist's Laboratory"; by a picture of Berzelius as a rather slim young man in knee-breeches, well-developed calves, court shoes and a tight, cut-away coat, seated in a well-upholstered chair, watching, whilst reading, a highly idealised piece of distillation-apparatus, heated by a Roman lamp—a picture reproduced from No. VII. of Kahlbaum's "Monographien." When one recalls the humble kitchen in the Swedish Academy's apartments which, under the despotic sway of old Anna the cook, served the great chemist as his laboratory, this representation of the well-groomed philosopher in the perfectly-appointed parlour provokes a smile. It is pleasing, but it is not history. More realistic is Prautschold's better-known drawing of the interior of the Giessen Laboratory as it appeared in 1842. It represents a crowded assemblage of workers who resemble the German students of opera-bouffe, but it is probably characteristic. As the names of those figured are known it would have added to the interest of the picture to have given them. Some of them at least are not unknown to fame. The remaining plate is a photographic reproduction of van't Hoff's private laboratory at Amsterdam, taken from Prof. Cohen's memoir. The illustrations are probably given as types of laboratories of their respective periods, but happier selections are available and might have been introduced.

The ideal history of chemistry has yet to be written. There already exist a number of works of the character of the one now noticed, but many of them are not much above the range of ordinary school histories. The subject is worthy of a fuller treatment; its several periods should be dealt with in special monographs and in the manner of professed historians. The story during the last 70 or 80 years—infinitely the most fascinating and the most fruitful period in its history—has not yet been adequately handled. But the man who could handle it most effectively is probably too busy in augmenting it.

T. E. THORPE.

Antarctic Polychæta.

Australasian Antarctic Expedition, 1911–14, under the Leadership of Sir Douglas Mawson. Scientific Reports: Series C—Zoology and Botany. Vol. 6, Part 3, Polychæta. By Dr. W. B. Benham. Pp. 128 + plates 6 + Map 1. (Sydney: Government Printing Office, 1921.) *12s.*

THE labours of Kinberg, Grube, Ehlers, Gravier, Pixell, Ramsay, Benham (1909), and others, besides those described in the *Challenger* volume, have rendered us more or less familiar with some of the Antarctic Polychæts. The present memoir of Prof. Benham, an able and experienced observer, adds notably to our knowledge of such forms as have been obtained within the half-circle round the Antarctic land. The materials on which his report is based came chiefly from Commonwealth Bay, Adelie Land (Australian Antarctic), though a few were procured off Macquarie and Maria Islands and Tasmania, the collection containing fifty-eight species, of which eleven are new. In his summary of Antarctic forms hitherto obtained the author shows that the largest number of species belong to the Terebellidæ, followed in diminishing numbers by the Syllidæ, Phyllodocidæ, Aphroditidæ, Maldanidæ, Serpulidæ, and Sabellidæ, the other families having fewer numbers. Moreover, some species occur in large numbers, such as *Thelepus antarcticus*, *Harmothœ spinosa*, and *Potamilla antarctica*, a feature not uncommon in similar species in European waters. Of his new species, perhaps the most interesting is *Amythas membranifera*, from Commonwealth Bay, an Ampharetid which has an introversible frilled membrane instead of the usual oral tentacles.

The author has extended the distribution of various known species, as well as, by the aid of well-preserved examples, added to our knowledge of their structure, sexual variations, and otherwise. Careful investigation had led Prof. Benham occasionally to differ from his predecessors, but he shows fully and fairly the grounds on which his arguments rest; *e.g.* in the distinctions between Harmothoë and Hermadion. He does not enter into the structure of the foot in diagrammatic vertical section as Mr. Southern has done in the Indian forms from the Chilka Lake, probably because such is unnecessary in the discrimination of species, though it may be useful in critical cases. The careful methods adopted by Prof. Benham enabled him, for instance, to observe the chitinous supporting rod in the long metastomial cirri of *Pelagobia vigueri* which M. Gravier had overlooked. It may be open to doubt, however, whether his new species *Sphærodorum spissum* is not more closely connected with the European forms than is at present supposed.

This research still further emphasises the fact that no special polychæt fauna characterises the Antarctic seas, and that in all probability in the diatom-ooze of the great depths between Australia and the Antarctic shores even a proportionally greater number of novel types exist than have hitherto been procured. Again, some cosmopolitan forms make their appearance in the Antarctic waters, such as *Phyllodoce madeirensis*, *Glycera capitata*, *Cirratulus cirratus*, and *Serpula vermicularis*. It is curious, however, that *Hauchiella tribullata*, a Zetlandic Terebellid, is not included in the captures, though it was found at Kaiser Wilhelm Land in the American Antarctic region. The author did not meet with examples of the incubatory habit which was thought by Gravier to be a feature of these cold southern regions, *e.g.* in *Eteone gaini* and *Flabelligera mundata* amongst the polychæts, and in holothurians, actinians, and colonies of tunicates. It is well to remember, however, that the incubatory habit is seen in British seas from fishes to cœlenterates.

If criticism may be offered, it is that the author might have made the discrimination of his new and rare species more easily accomplished if he had given at the commencement of each a brief epitome of the specific characters. The accompanying ten plates have their figures fairly represented in lithographic ink, though they lack the fine touch of stone-engraving. The descriptive letters have been omitted from the figures throughout. The entire memoir is a credit to the Australian Government, and to Prof. Benham, whose ability and wide experience enabled him to treat the subject in an effective manner.

W. C. M'INTOSH.

European Archæology.

A Text-Book of European Archæology. By Prof. R. A. S. Macalister. Vol. 1, *The Palæolithic Period.* Pp. xv+610. (Cambridge: At the University Press, 1921.) 50*s.* net.

SEVENTY years ago the Scandinavian founders of European archæology regarded the shell-heaps or "kitchen-middens" as containing the earliest traces of man's handiwork. Ever since then it has been found necessary to shift man's beginnings further and further into the past, so that now Prof. Macalister is obliged to devote a whole volume, containing nearly 300,000 words, to reach the point at which his Scandinavian predecessors began their narratives. For the type of implement, in stone and in bone, found in the oldest shell-heaps the author adopts the recognised French term "Campignian," although he is of opinion that the culture represented in the shell-heaps was actually evolved in the Baltic Area. By a strange coincidence, if we are to follow our author implicitly, it is with the introduction of this shell-heap or Campignian culture into Ireland that the history of man commences in our sister-island. "No remains of the Palæolithic period to the end of the Magdalenian stage," writes Prof. Macalister, "have been found in the north of England or else in Scotland or in Ireland, some injudicious publications notwithstanding." The Professor of Celtic Archæology in University College, Dublin, has thus the advantage of surveying the ancient cultures of Europe from a land untrammelled by palæolithic tradition. His first volume covers cultural periods which are unrepresented in Ireland.

Where, when, and how, then, does the modern story of European archæology begin? One may reasonably complain of having to wade through some two hundred preliminary pages before reaching the point at which Prof. Macalister commences his archæological narrative. The first chapter is spent in defining what archæology is and what it is not; the second is devoted to the elements of geology, the third to the evolution and classification of mammals, the fourth to the evolution of man and classification of races, the fifth to eoliths and to *eolithists*, the name which the author gives to those who believe in eoliths as products of human hands. As the following passage shows, Prof. Macalister refuses to begin his archæological narrative with eoliths:—

"The question that these flints present to us is primarily: Are they the work of a conscious agent, fashioning them for a definite purpose, or are they not? The answer to this question appears to be almost wholly subjective, not objective, and is therefore outside the region of scientific study, except perhaps for the psychologist."

We fear that Prof. Macalister understands as little of psychology as of eoliths. For him, true archæology begins with types of flint implement which even a child can perceive have been artificially fashioned.

Archæology is construed in a wide sense by Prof. Macalister. It is made to include not only all things which have been made or used by past generations of mankind, but also skulls, bones, teeth, psychology, and religion. For a writer who warns his readers on almost every page against possible fallacies, it is somewhat daring for him to assert that "Man develops a religious instinct." Then, again, when discussing the "psychology of middle palæolithic man"—men of the Neanderthal type—he not only boldly asserts that they had a religion, but proceeds to draw a picture of this long dead and extinct type of humanity sitting round the fire and discussing momentous problems.

"One would tell of a dream that he had had, in which the dead had appeared to him; another would relate how something, he knew not what, but which surely was not of the common things of nature, had

startled him when he was wandering abroad in the gloom of the forest" (p. 343).

Such fancies may find a place in a schoolboy's essay, but are altogether out of place in a massive work devoted to the archæology of Europe.

The illustrations, which are excellent and numerous, make up for much that is deficient in the text. Students will also be thankful for references to many recent papers and monographs. There is no doubt a real need for such a text-book as this written in English and designed for the use of students of archæology—a text-book to serve as a standard work. We only regret that the author, while displaying a most commendable and painstaking industry, has not risen to the height of his opportunity. A. K.

Indian Game-Birds.

The Game-Birds of India. By F. C. Stuart Baker. Vol. 1, *Ducks and their Allies* (*Swans, Geese, and Ducks*). Second edition. Pp. xvi + 340 + pl. xxx (4*l.* 4*s.* net.) Vol. 2, *Snipe, Bustards, and Sand-Grouse.* Pp. xvi + 328 + pl. xix (3*l.* 13*s.* 6*d.* net.) (Bombay: Bombay Natural History Society; London: J. Bale, Sons, and Danielsson, Ltd., 1921.)

THE first of these volumes, dealing with Ducks and their allies, is the second edition of a work published by the author in 1908, which again was a reprint from a series of articles which appeared in the Journal of the Bombay Natural History Society. The matter has therefore had the advantage of two revisions and is brought completely up to date as regards nomenclature and records. The second volume, now before us, deals with birds which are included by the sportsman among the game-birds, though in scientific classification they are not so. These are the Snipe, Bustards, and Sand-Grouse. Two further volumes are promised on the Pheasants and Partridges, and with these four by his side the Indian sportsman and amateur naturalist will be very completely equipped not only to identify the game-birds he commonly meets with, but to obtain all the information in regard to their habits and occurrence that is known. Mr. Baker, though now for some years retired from service in India, spent the greater part of his life there, and in these volumes he has given us much of his own observations and experiences; to these he has added contributions from others, both previously published and derived from information sent him by his many Indian correspondents. As a result we have here a most complete account of the life history of these favourite birds.

In every case a good description of adults and nestlings is followed by paragraphs on the distribution, nidification, and general habits, while every species is illustrated with coloured plates. These are most of them by Mr. H. Grönvold, though some of those in the first volume are from the brush of Mr. G. E. Lodge and the late Mr. J. G. Keulemans. They are reproduced by chromolithography in the case of the Ducks, and by the three-colour process in the second volume. The chromolithography is certainly softer, and perhaps gives a more artistic result. In the three-colour process the colours are decidedly sharper, and better defined, though the very shiny paper necessary for this process certainly detracts from their artistic appearance.

Perhaps one of the most interesting facts recorded in these volumes relates to the habits of two species of sand-grouse, *Pteroclurus alchatus* and *P. senegalensis* (formerly known as *P. exustus*). Although these birds inhabit the dryer and more desert regions of north-west India and Central Asia, they are, unlike some other desert forms, unable to do without water, and resort in enormous flocks to well-known watering-places at certain fixed hours to quench their thirst. It has always been stated by native shikarees that when they have young broods they convey water to them by thoroughly soaking the feathers and the breast and underparts, and that the young birds suck the water thus conveyed to them. This story has been confirmed by Mr. Meade Waldo, who has repeatedly bred *P. alchatus* and other species in confinement and has watched the process of the male saturating the feathers of his breast and subsequently satisfying the thirsty brood.

Nearly all intelligent travellers and even residents in tropical countries have experienced the irritation and annoyance of being unable to identify the strange forms of animal and vegetable life with which they come in contact. Such works as the present, with its beautiful series of coloured plates and carefully prepared descriptions, cannot fail to be of the greatest assistance to all those whom duty or pleasure take to India, and we must congratulate Mr. Baker and the Bombay Natural History Society on their enterprise in supplying two such fine volumes at a comparatively reasonable price as things are at present. We shall look forward to the appearance of the other two volumes promised within a reasonable period.

Water Flow in Pipes.

Hydraulics of Pipe Lines. By Prof. W. F. Durand. (The Glasgow Text Books of Civil Engineering.) Pp. xvi + 271. (London: Constable and Co., Ltd., 1921.) 18*s.*

THE subject of the flow of water in pipes and channels is not only of very considerable historical and scientific interest, but is also one of

great practical and economic importance. It is frequently stated that hydraulics is an empirical science because water differs from the ideal fluid to such an extent that the theoretical hydrodynamical investigations are not of much value to the hydraulic engineer. While this in a measure is true and it is necessary to resort to experiments to determine the exact form of the formulæ which express the flow of water along pipes and the co-efficients to be used in them, nevertheless, there are many problems connected with the flow of water in mains which are capable of analytical treatment, and the volume under notice has for its principal aim the discussion of these problems.

In chapter 1 the general hydraulic principles of flow are discussed and empirical formulæ such as those of Chezy and Kutter are quoted, tables of co-efficients to be used with them for clean pipes being given. There is no attempt whatever to give particulars of modern researches, and so far as this chapter is concerned with loss of head by friction, no experimental work done during the last thirty-five years is considered worth mentioning. As regards losses by bends and elbows recent researches have been referred to, but no consideration is given to the very important question of the change in the carrying capacity of a pipe with time. The general principles are, however, clearly discussed, and it may fairly be said that this chapter is written as an introduction to the chapters which follow, in which the problems of the surge chamber and water hammer in pipe lines are very fully discussed.

The two succeeding chapters deal very fully with stresses in pipe lines, with the materials of construction, and with the design of pipes. The last chapter of the volume deals with the flow of oil along pipe lines. The important effect of temperature on the viscosity is emphasised and a curve is given showing how the pressure drop per mile can be obtained when the temperature is changing.

There are four appendices in which certain special theoretical problems are dealt with. In Appendix 1 the general theory of pipe line flow is considered from the theory of dimensions. In this connection it is surprising to an English reader to find no reference to Lord Raleigh, or to the work of Stanton and Pannell, or Lees, and throughout the whole book there is very little reference to much important work that has been done in this country. To English readers also such symbols as (*pf2*) and (*f3s*), meaning pounds per square foot and cubic feet per second respectively, may appear a little awkward, but the notation used throughout the book is summarised at the commencement. The work should prove of value to serious students of the subject.

F. C. L.

Recollections of a Geologist.

Memories of a Long Life. By the Rev. Canon T. G. Bonney. Pp. iv+112+vii. (Cambridge: Metcalfe and Co., Ltd., 1921.)

A LIMITED edition of this little book has been printed. It is meant primarily for Cambridge readers, but will be perused with affectionate interest by the many other friends of its author. It has also some wider appeal as the unaffected and revealing life-story of a last-century Don. Not many of us can aspire to a retrospect so gratifying in its entirety; and we congratulate the author on his enviable possession.

Beginning in 1837 with the hearing of minute guns on the death of William IV., the "Memories" cover a period of over eighty years (and are happily still continuing). Of the wide scientific achievements of their narrator they tell little, but are vivid with incidents and anecdotes of his boyhood, undergraduate days, and later professional life in Cambridge and London, with recollections of eminent men and abnormal weather. In the parlance of relativity, the events for the most part pertain to a particular system of reference and would scarcely be recognisable as events in another system; but they combine, within their limits, into a concordant and sharply individualised picture of a career "crowded with culture." They exhibit a life of continuous mental and bodily activity; terms of strenuous duty alternating with pleasant vacation tours in the Alps and elsewhere, usually fruitful in scientific results; and in their long range they recall the changes, both in material things and in mental outlook, that have become apparent during their course. It is a cheerful picture, in which we may occasionally catch the trace of vigorous old controversies that, like the little whirlwinds of hot weather, have now and again raised temporary commotion within the sphere of their impact without disturbing the broad serenity of the plain.

There is strong spice in the caustic remarks on the unseemly behaviour and dress of some of the undergraduates of to-day, and in the comments on the motor-car and bicycle, the latter of which "shoots out silently from hidden byeways, the rider never dreaming of using his bell." But the good-nature underlying it all is illuminated by the episode of a happening, years and years ago, when the author, then junior Dean, cleverly detected an undergraduate in a prankish breach of order in Chapel, and brought him before the Seniority with a stern demand on its unwilling members that "if you do not send him down you must appoint some one else to sit there in future,

for I will not"—this Draconian severity being pressed for because "the penalty was not really so heavy as it seemed, for as I privately knew the man had just kept his term"!

The index should be read; it is an epitome of the book.

Our Bookshelf.

Der Torf. Von Prof. Dr. H. Puchner. (Enke's Bibliothek für Chemie und Technik unter Berücksichtigung der Volkswirtschaft: Band I.) Pp. xvi+355. (Stuttgart: Ferdinand Enke, 1920.) 40 marks.

PEAT is always an attractive subject for the investigator, and particularly for the inventor, as it seems to promise so much in return for so little effort. It lies on the surface and needs no expensive mining operations; it is often on the top of a hill and can be run down to the consumer by gravitation, and it is capable of yielding fuel, ammonia, and various oils by distillation or heating processes, for which it can itself provide the necessary energy.

The book under notice gives a useful summary of the properties of peat, especially of those studied by the German workers, and it will prove useful to prospective investigators who wish to know something of the nature of the material they have to handle. The great difficulty up to the present has been the drying: in its natural state peat may contain 90 per cent. or more of water, and this has to be reduced considerably before economic utilisation is possible. So far no method that is generally satisfactory seems to have been evolved. The author helps by giving an account of the methods adopted in Carinthia, Oldenburg, and elsewhere, as well as a list of methods proposed or used in factories where peat is converted into saleable products. The number of methods of utilisation suggested or actually tried is considerable. During the war attempts were made in Germany and Sweden to use it for firing railway engines, but it was found necessary to fill not only the tenders but also one or two waggons with fuel if any length of journey was contemplated. Much more successful are the efforts to convert peat into power gas, and one feels on looking through the book that the problem of utilisation of peat must surely be near its solution. It would certainly add to the resources of the world if satisfactory methods could be worked out.

The Homogeneous Electro-Thermic Effect. (*Including the Thomson Effect as a Special Case.*) By Carl Benedicks. (Ingeniörs Vetenskaps Akademiens: Handlingar Nr. 5, 1921.) Pp. 117. (Stockholm: A.-B. Svenska Teknologföreningens Förlag; London: Chapman and Hall, Ltd., 1921.) 15*s.* net.

THE Swedish Academy is issuing in English a series of memoirs on scientific subjects in order to make the work of Swedish men of science more widely known, and the volume under notice is the fifth to be issued. It deals with the transport of heat along a conductor through which an electric current is passing, and the author concludes from his measurements that there is, in addition to the Kelvin effect, a further flow of heat with or against the electric current even when the conductor is homogeneous and originally at a uniform temperature. His measurements are in general made on long cylinders, the centre of each being turned down to a narrow neck. The electric current through the neck causes a transport of heat to one or other side of the neck, and the difference of temperature of the two sides is measured by thermo-junctions. This difference does not vary with the magnitude of the electric current according to the same law as the Kelvin effect, nor is it always of the same sign as the latter. The author proposes to call this new effect "the homogeneous electro-thermic effect."

The Wisdom of the Beasts. By C. A. Strong. Pp. x+76. (London: Constable and Co., Ltd., 1921.) 5*s.* net.

THIS is not a zoological treatise on animal instincts and the like, but a series of philosophical fables of excellent humour—indeed the prefatory quotation from the Prologue to Phædrus' Book I. makes us shrewdly suspect the author of exquisite satire directed at relativity and other scientific concepts. The fable of "The Bird and the Fish" will cause amusement to the disciples of Einstein:—a young bird, inexperienced in the phenomenon of moving air and in its effects, is set thinking by the fact that on a certain day it took less time than usual to fly from the church steeple to the stream, and more than usual to make the return flight: after much cogitation it satisfies its philosophic soul thus:—"Ah! I have it at last; what has changed is not the field, but the clock. By flying away from a clock you alter its time-keeping so that it loses, and by flying towards it you alter its time-keeping so that it gains. The time-keeping of clocks is not a fixed and unalterable thing, but depends on whether you move or stand still." And such is the style of the majority of these fables.

Analyses and Energy Values of Foods. By Dr. R. H. A. Plimmer. Pp. 255. (London: H.M.S.O., 1921.) 6*s.* net.

THIS work, which was carried out for the War Office authorities, contains the most comprehensive series of food analyses performed in the British Isles. As the author points out, they are best regarded not as a replica of but as a supplement to the very complete set of data by Atwater and Bryant, U.S. Department of Agriculture. In some cases the number of analyses is not great, but since the results are from foods as actually supplied in Great Britain, they carry more weight in this country than more numerous figures published for other countries. The tables are very carefully arranged, so that the composition of the entire food, or any part of it, may be seen at a glance. There is also an excellent summary of analyses in a form suitable for calculation. Information is given regarding the methods employed, and a short appendix tabulates the common food stuffs which do, and also those which do not contain accessory food factors or vitamins. The volume undoubtedly represents a valuable and distinct advance in knowledge.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Science at the Post Office.

I HAVE always regarded expressions of opinion in the leading articles of NATURE as founded on ascertained facts impartially considered, and it is therefore with much regret that I feel impelled to protest against the article entitled "Science at the Post Office," which appears on the front page of your issue of April 1.

I shall try to put the writer's main contentions, and my replies to them, very briefly.

(1) *Complaints regarding the telephone service after the war are closely connected with the question of the technical qualifications of the engineering staff.*

This is not true in the sense intended to be conveyed. It is the easiest matter in the world to demonstrate that the complaints do not arise from any conditions involving science or research, but are due to the quite simple and commonplace fact that the home service had suffered for five years by the withdrawal of over 13,000 of its engineering staff for military duties, and by the loss of a large proportion of its experienced telephone operators.

The telephone system transferred to the State in 1912 was in urgent need of reconstruction and extension on a great scale. Such work on what may be called a living organism, and one very complex and sensitive, has to be carefully planned and executed. It was in full swing in 1914, when it had to be abandoned at the call of vital national necessity. Its resumption after the war was attended for some time by great and well-known difficulties in the supply of materials and in the retransformation of factories to peace conditions. It is now well in hand again. New operators have been trained, and what is needed to put things right is the construction of exchange buildings, switch-boards, and cable plant in adequate volume. The same conditions have applied to all nations involved in the war, and have no direct relation to the efficiency or scientific attainments of their engineering staffs. Nowhere was the post-war deterioration of telephone service more conspicuous than in the United States of America, although the depletion of telephone resources in that country lasted for less than half the time, and was proportionately very much less serious than in Great Britain.

(2) *A scheme, introduced in* 1907, *for recruiting* 25 *per cent. of P.O. engineers by open competition has remained in abeyance since* 1912, *and has now been replaced by a scheme whereby only* 20 *per cent. of new entrants will be obtained by open competition.*

The implication here is that standards of qualification, set up by a former Engineer-in-Chief, are now being reduced, but the facts are quite otherwise. There were good reasons for suspending the scheme in 1912, as practically the whole engineering staff of the National Telephone Company was then transferred to the Post Office, and had to be equitably absorbed in its engineering organisation. Since the war very few new appointments to the engineering classes have been made. The scheme of 1907 provided for the admission of college-trained youths by an examination considerably lower than that of an engineering university for a science degree. The present scheme requires all candidates to possess a science degree before they are eligible to sit for the competition for Assistant Engineerships, and the character of the examination is fully equal to the degree examination of the universities.

Another important point ignored in your article is that the present scheme has set up a separate open competitive examination, for which young men who have studied at universities and technical colleges are eligible. The character of this examination is a little lower than that for graduate Assistant Engineers, and successful competitors will be appointed as "Inspectors" in the Engineering Department. In this position they will be eligible, along with other selected Post Office employees, for a further series of competitive examinations for a further 20 per cent. of the vacancies for Assistant Engineerships (in the same subjects as in the examination for graduates but of a slightly less advanced grade) as well as for promotion in ordinary course. It is therefore a wide departure from the truth to say or imply that the proportion of full-time college men among recruits for Post Office engineerships has been limited to 20 per cent. And, quite apart from these outside recruits, I maintain emphatically that no man who is not, in the best sense of the word, a college student has any chance of appointment as a Post Office engineer. The fact that a man has had the grit and capacity to win his spurs by evening studies, extending over a period of many years, while following his daily employment is, to my mind, the reverse of a disqualification. Among the thousands of young men in the lower grades of the Post Office Engineering Department there exists a splendid recruiting ground for the higher positions. These men are selected with care in the first instance, and they are watched and reported on with equal care. They know that promotion depends on character and efficiency. The idea of "the field-marshal's baton" is rife among them, and I, for one, sincerely hope that the Post Office will always give it full encouragement. I have no fear of being charged, in any informed quarter, with belittling the need for mathematical and scientific attainments of the highest order in connection with the telegraph and telephone services. But the field of the Post Office Engineering Department is so wide that its everyday work calls for qualifications of many different kinds, and I speak from knowledge and experience when I say that the engineer who combines high character and business and administrative capacity with long Post Office training and continuous self-education is an officer of first-class practical value for whom there will always be abundant room.

(3) *The Chiefs of the Post Office Engineering Department should be men from outside the department, who have reached a position of eminence in the general engineering profession.*

I need not say much on this point. Two of my four Post Office predecessors in the position of Engineer-in-Chief, during the past thirty years have been Presidents of the Institution of Electrical Engineers, and others have only been prevented by the shortness of their term of office from attaining the same position. No one who understands the complexity of modern telegraph and telephone engineering will contest the statement that the position of Engineer-in-Chief will be better filled by the most highly qualified telegraph and telephone engineer and administrator in the country than by the most highly qualified general engineer. The American Bell Telephone Organisation is rightly held up to us as a model. In no case would the heads of that organisation dream of appointing a chief engineer who had not spent the main part of his lifetime in

telephony. The senior ranks of the department—Assistant Engineer-in-Chief, Staff Engineers, and Superintending Engineers—contain many men much more fully qualified for the premier position by capacity, general and scientific education, and special engineering and administrative experience than any outside engineer could possibly be, and the Postmaster-General is to be congratulated upon the field of choice at his command. This is well known to the whole staff, and I need say nothing of the effect upon its *moral* and *esprit de corps* which would follow the adoption of the principle recommended in your article.

I am afraid I have already over-trespassed upon your valuable space, otherwise I could give much information as to the brilliant scientific work performed by Post Office engineers. Many of their productions are classics in the field of telegraph and telephone engineering and research.

The Post Office service is a "silent service," except when gratuitous and undeserved attack stings it into retort. I can without hesitation challenge any critic to produce experts in any branches of telegraph or telephone service who would not be at least equalled by Post Office officials whom I could name.

W. Noble,
Engineer-in-Chief.

General Post Office (West), London, E.C.1,
April 19.

Sir William Noble places a construction upon the words used in our article which they cannot reasonably bear. The purpose was to direct attention to the Report from the Select Committee on the Telephone Service (1922), a document very generally admitted to be one of the most important and valuable of parliamentary papers issued in recent years; and we believe the article to which Sir William Noble refers to be a fair comment on a matter of great public interest. The Committee definitely says in this Report: "We cannot agree with the trend of Post Office evidence that from a telephone point of view the existing organisation works perfectly well, however cleverly managed it may be," and therefore substantially finds that there was good foundation for the complaints concerning the inefficiency of the Post Office telephone service: the Committee, in consequence, recommends a "*thorough reform*" (our italics) in the Post Office organisation. The minutes of the evidence taken by the Committee are contained in a public document (H.C. 191 of Session 1921), and therefore the names of the witnesses and particulars concerning them can be readily ascertained by those who so desire. Now, it is true that evidence was given by witnesses representing newspaper organisations, namely, the Press Association and the Newspaper Society; on the other hand, apart from the Post Office officials, the great majority of the other witnesses who came before the Select Committee attended in order to represent important organisations of various kinds, some fourteen in all, such as Chambers of Commerce, Agricultural Associations, and two Municipal Corporations. The general trend of the evidence of the latter witnesses amounted to a criticism of the quality of the telephone service, and although a great volume of the fault-finding was directed against the administrative system of the Post Office, many of the adverse comments made by the witnesses referred to work of a technical kind.

The volume in which the evidence in question is to be found was indicated in our article, and all who so desire can therefore consult the actual statements of witnesses as put on record therein, and can at the same time naturally draw their own conclusions in relation to the matters under investigation. We take, and have long taken, a deep interest in the utilisation of science in the public departments, and many sources of information on this matter are open to us; in consequence, we have considerable personal knowledge of the conditions prevailing in the technical branches of the various government departments, including the Post Office.

To deal with the first of Sir William Noble's contentions. We do not deny that during the period of the war the Post Office services had had to be carried on under exceptional difficulties. We also had information some time ago from American sources showing that the telephone service in America had deteriorated during the war period after the U.S.A. Government established its control upon the telephone undertakings; afterwards we learnt from American business men that the telephone service in their country began at once to improve as soon as the government control was removed, and was quickly brought again to a high level of efficiency. We fail, to see, however, the connection with the war situation alluded to by Sir William Noble in his letter, and the fact to which attention was directed in our article, namely, that foreign telegraph and telephone administrations have for a long time past demanded a higher standard of technical qualifications from applicants for positions in their engineering departments than has the Post Office.

As regards the second of Sir William Noble's contentions, we cannot understand how he arrives at the conclusion that the language employed in the reference in our article to the Post Office recruiting scheme of 1907 contains an implication that "standards of qualification, set up by a former engineer-in-chief, are now being reduced." The purport of our remarks on the subject is to the effect that we disapprove of a policy the consequence of which will be to reduce the percentage of engineers entering the Post Office by open competition below that represented by Post Office officials to the Select Committee of 1912—an extract from the Report of which is given in the article—as being then necessary. Our contention is that, responsible Post Office officials having stated publicly ten years ago, for the reasons given in the extract quoted, that it was "undesirable to limit the field of recruitment for the class of assistant engineers to those within the Department," and also that it was "important that 50 per cent. of the vacancies should be filled by young men of wider education and higher engineering attainments than are usual amongst Post Office servants," it cannot be right, and in the interests of the public service, now to reduce the percentage of engineers to be recruited by open competition to 20 per cent. only, as would appear to be the policy of the Post Office at the present time.

Within the limits of space at our disposal we are unable to go into details in connection with the method proposed for recruiting the subordinate grades of the Post Office engineering department: we were, of course, fully aware of the scheme outlined by Sir William Noble in his evidence before the Select Committee (Q. 2227); an opportunity may occur for dealing with the subject at a later date. However, it may be said at once that we fully recognise, and are in entire agreement with the view, that an avenue of promotion to the highest rank in the Post Office should be open to every *properly and sufficiently qualified* individual, irrespective of when or where he reaches the standard of qualifications essential to enable him *skilfully* to discharge the higher duties, and irrespective also of the grade in which he first entered the public service. But on account of the facilities, such as County Scholarships and otherwise, which are now open to every young man of ability, regardless of the means of his parents, for obtaining

at an early age the highest standard of technical education available in this country, and for other reasons, we are of opinion—and our opinion is shared by important bodies representing the engineering profession—that the Post Office recruiting scheme outlined by Sir William Noble in his evidence is not of a kind which will best meet the needs of the situation, nor one which most effectively promotes the best interests of the State. Schemes of internal departmental examinations for promotion purposes are unsatisfactory; there is no guarantee that they will not be at some time reduced to a farce, *e.g.*, such as by allowing candidates to qualify in single subjects at relatively long intervals of time, and there are also other objections to such an arrangement.

As to Sir William Noble's third contention, we recognise, of course, that in the past the position of engineer-in-chief at the Post Office occasionally has been held by distinguished men, but we hold that quite a different stamp of early education and training is now required to produce the leaders who are to be called upon to devote their later years to administrative work in a technical sphere. Conditions have long passed the pioneer stage when knowledge had to be acquired and accumulated little by little, and day by day, in the course of daily work in order to build up materials for the science of one's particular branch of technology for the use of future generations of workers in that field. There are in the ranks of the Post Office engineers men of considerable technical ability, and nothing has been said to the contrary in these columns. But we are as averse to a government department relying for its reputation mainly on the eminence of one or more of its former chiefs, as we are to a young man claiming distinctions on the mere ground that one or more of his forebears was, or were, undoubtedly a man, or men, of brilliance. Further, one swallow does not make a summer, and, on the same principle, a small percentage only of able men in a large and complex department cannot possibly maintain it at a proper level of efficiency.

What we desire to see introduced is the method of selecting departmental chiefs indicated in our article, and the adoption of the procedure there recommended. We, therefore, cannot contemplate with the same satisfaction and equanimity, which Sir William Noble appears to do, the present situation. The status of the chief technical adviser in a government department dealing with the highly scientific and complicated problems associated with the telegraphs and telephones is at present considered to be equal in the matter of salary—the outward indication of status—to a position the importance of which is estimated to be one-half only of that of the chief administrative officer of the Department, and just about two-thirds of that of the administrative officer in the second position. We are consequently in agreement with the recommendations of the Select Committee which proposes the introduction in this country for the management and control of the technical services of the Post Office of an organisation similar to that of the Administrative Board of the Swedish Telegraph Department, and it is to be hoped that measures will be taken at the earliest possible date to carry out a thorough reform of the Post Office on the lines indicated in the Report of the Select Committee of 1922.

THE WRITER OF THE ARTICLE.

Discoveries in Tropical Medicine.

IN NATURE of April 29 there occurs, beginning at line 30 of page 549, the following statement: "The fact is that Manson's 'suggestion' that the Filaria of elephantiasis is actually carried by mosquitoes from the blood of one person to that of another remains to this day a 'suggestion.' It has not been established as a fact."

This statement is so strangely erroneous, both in concept and in fact, that were it not made in a letter professing to rescue truth from misrepresentation, written by one who in his own department of natural science has long enjoyed a commanding position, it would be kinder to all concerned to ignore it.

From the context it is evident that the term "filaria of elephantiasis" refers to the parasite known in pathology as *Filaria bancrofti*, this being the species responsible for a variety of pathological conditions in man, among which most pathologists, but not all, include elephantiasis.

Now in pathology the name *Filaria bancrofti* belongs to the adult worm, which lives not in the blood but in the *lymphatics*; we must assume therefore that by the expression "Filaria of elephantiasis . . . carried from the blood" is intended not the adult but the embryonic form of the worm—known to pathologists as *Microfilaria bancrofti*—which does occur in the *blood*.

Making these necessary assumptions, in the attempt to clarify an ambiguous statement, the interpretation is that a "suggestion" is extant that *Microfilaria bancrofti* is carried by mosquitoes from the blood of one person to that of another, and that this "suggestion" has not been proved.

Such a suggestion may have been made by some unimaginative individual; such an accidental mechanical transfer might conceivably occur; but since the microfilariæ cannot develop in the blood, their transfer from the blood of one person to the blood of another would throw no light on the question—how do the microfilariæ in the *blood* of one person become the filariæ in the *lymphatics* of another? The suggestion would remain—like Touchstone's shepherd's suggestion as to the cause of night—an idle and obtuse suggestion, not worth verification.

Any one acquainted with the facts and their implication, desirous of proclaiming the truth to readers of NATURE, who are not all parasitologists and pathologists, would not introduce an ambiguous term like "filaria of elephantiasis" into his text; for although *Filaria bancrofti*—which is the worm often associated with elephantiasis—is without doubt abundantly pathogenic to man in other ways, there are still some pathologists who are not convinced that it is responsible for the particular disease elephantiasis. The possibility should have been kept in mind of an inference being drawn that because some doubt still existed as to the full extent of its pathological significance the pathogenetic character of the filaria is still a matter of "suggestion"—a lamentably erroneous inference.

Readers of NATURE should have been informed that the whole history of *Filaria bancrofti* and its relations to man and to mosquitoes is to be found in text-books, some of them written by men who have themselves confirmed the facts and know at first hand what they are describing. To be brief: it has been known for many years that the microfilariæ floating in the bloodstream of an infected man are sucked up with his blood by mosquitoes of many kinds that bite him after sundown; that they get into the stomach of the mosquito, and thence into the insect's muscles, where they grow and develop; and finally, that as larvæ some of them get into the insect's proboscis, whence, when the insect bites other men, they escape on to the victim's skin and bore through into his lymphatics. Every stage has been followed, though naturally for the final stage the evidence is based—quite legitimately—on experiments in the laboratory with an analogous species of filaria.

The discoveries of those stages in this wonderful

history that are passed in the stomach, muscles, and body-cavity of the mosquito, and of the necessary intermediation of the insect in the spreading of filarial disease among men, were made by a busy medical practitioner, working alone in China, in 1877. They were reported at a meeting of the Linnean Society held in March 1878; they were published in the zoology section of the Society's Journal for 1879; and an amplified account, with a plate of 46 figures representing every stage of the worm's development in the mosquito, from embryo in the stomach to larva in the body-cavity, subsequently appeared in the Transactions of the Society for 1884, at p. 367.

Not even the loneliest man, of course, works alone; as Carlyle says, "all past inventive men work with him there." But in workers there are varieties of aptitude and varieties of circumstance; and in discoveries there are varieties of worth. The discoveries of the highest class are those that enlarge the boundaries of science, that increase understanding, and open out new fields of action. The discoveries, worked out in unpromising circumstances, by that great original genius Patrick Manson, and reported to the Linnean Society in March 1878 and 1884, were of this kind: they established a great luminous principle of pathogenesis — the principle of the necessary intermediation of the bloodsucking insect: and of every man who applies this principle anew it may be truly said that always in the background Patrick Manson, may peace be with him—acknowledged or forgotten—"works with him there."

A. ALCOCK.

Nectar-Sipping Birds.

THE device of *Mirafra Assamica* to reach the nectar in the flowers of Castanospermum (noted in NATURE of April 15, p. 489) has its parallel among British birds. The blooms of several Asiatic species of rhododendron contain much honey, and many of these are defaced at this season by the great tit (*Parus major*), the blue tit (*P. cæruleus*), and probably the coal tit (*P. ater*) pecking holes in the tube of the corolla and tearing away the upper petals to get at the nectary. In some gardens bumble-bees have learnt to make a similar short cut to the nectary of *Salvia patens*; the legitimate entrance, which is furnished with a neat mechanism to ensure cross fertilisation by humming-birds or long-tongued Lepidoptera, being too narrow to permit access for Bombus. Knowledge of the trick, however, is not universal among bumble-bees; for I have found that in some gardens the blossoms of this Salvia remain intact.

HERBERT MAXWELL.

Monreith, Whauphill, Wigtownshire, N.B.

Aeroplane Crashes: The "Hole in the Air," the "Spin."

THE kind of accident in which Sir Ross Smith and Lieut. John Bennett lost their lives appears to be due to an attempt on the part of the pilot to change the direction in which the aeroplane is moving more abruptly than is consistent with its momentum. Suppose, for example, that the aeroplane could be instantly turned round to face the point from which it had come, its momentum would inevitably cause it to travel an appreciable distance tail first. An approach to this condition constitutes the "hole in the air" of the early airman, and is the harbinger of the "spin": it is the equivalent of "skidding" in the motor-car and is due to exactly the same cause, namely, momentum run riot.

As the motion of translation through the air (the one essential condition to the flight of heavier-than-air machines) is being lost the aeroplane begins to fall, and it is difficult to imagine that the pilot can do anything to arrest the fall except perhaps when it accidentally takes the form of a slanting nose-dive. Immunity from this class of accident can only be attained by judicious "banking" on curves of a radius suitable to the aeroplane and its velocity at the moment, and the complete avoidance of quick-turning movements undertaken for any purpose. Is it possible that in some aeroplanes the steering appliance is unnecessarily powerful and apt in that respect to deceive the pilot?

W. GALLOWAY.

The Athenæum, April 18.

DR. GALLOWAY directs attention to an important aspect of aviation in his reference to a recent accident. The type of failure—a spinning nose-dive—is unfortunately too common, and on any reasonable statistical basis may be expected to remain so until improved aeroplane design is achieved. Whilst rapid turning facilitates "spinning" the fundamental cause is peculiar to the aeroplane and a property of wing form and arrangement. The support for an aeroplane arises from the aerodynamic characteristics of the wings, and a fundamental change occurs when the angle of attack exceeds some 15 or 20 degrees. Above this critical angle the ordinary motion of an aeroplane is extremely unstable and the natural motion is a spin with the nose well down; the details of the instability are clear, but the remedy is unknown and only dimly foreseeable. The difficulty put before the pilot by the instability is accentuated by simultaneous loss or reversal of control. Scientific research is here required; it is, indeed, very urgently needed, but the prospects of obtaining the opportunity are far from good. Financial stringency and insufficient sympathy for research by the Air Ministry are the great difficulties, and not lack of scientific ability in the country. It is to be regretted that the loss of famous men is required to give point to a problem of long standing and that the Aeronautical Research Committee has not the necessary authority to carry out work which its reports show that it recognises as very important.

L. BAIRSTOW.

The Blood-cells of the Oyster.

THE blood-cells (leucocytes) of the oyster have been a subject of great interest ever since Lankester first observed them crawling on the outside of the body parts of the oyster. Recently I have found that these leucocytes will live for 3 or 4 days in sea-water in dishes. If the leucocytes be set free by teasing up the heart of an oyster or by placing pieces of the palps or bases of the gills in sea-water in a petri dish, they are seen at first to be aggregated mainly in masses, but within ten minutes to half-an-hour it will be found that the leucocytes are spread over a large portion of the dish and creeping away from the masses in a flattened amœboid condition on the bottom of the dish or even on the surface film. At the end of 3 or 4 days the cells round off and die. The length of time they remain alive, however, should make these leucocytes—which are very easily obtainable—valuable as subjects for physiological investigations, and further, suggests that it might be possible to *cultivate* them in an appropriate medium under appropriate conditions.

The mode of propagation of leucocytes in oysters is not known, and certainly no definite organ is known to produce them. A division of a living leucocyte has been observed to the extent that the resulting halves could be seen to be separated only by a relatively very long and very fine connecting thread,

which was finally lost sight of; but a complete division could not be stated to have been seen in this case, and other observations point to the formation of long protoplasmic connexions between the leucocytes of the oyster as a repair phenomenon somewhat equivalent to the clotting effect of blood in vertebrates. The cultivation of the leucocytes of the oyster may nevertheless be possible, since Carrel and Burrows and later workers have shown that even specialised tissues of vertebrates can be grown outside the body in media and under conditions now well-known. A successful cultivation of the leucocytes of the oyster would undoubtedly suggest methods of attacking the problem of the cultivation of human leucocytes outside the body under known conditions and to yield known properties in the leucocytes. The potentialities of human leucocytes cultivated under such conditions may be so great that sufficient excuse is provided for any speculation which may point even faintly to a method by which such a desirable product may be attained.

J. H. ORTON.

The Marine Biological Laboratory,
The Hoe, Plymouth, April 28.

Periodical Phenomena in the Temperature Functions of Certain Properties of the Metals.

IT is well known that the assumption of a quantum distribution of the energy of vibrations of the atoms in solids can be used to explain changes of the specific heat and other properties at low temperatures. Now this quantum distribution also seems to reveal itself in a more direct manner.

I have measured, partly in collaboration with Mr. F. Gunneson, the thermoelectric force at the ordinary temperature of specimens of iron and tungsten that had been successively heated at different temperatures and each time rapidly cooled. The thermoelectric force taken as a function of the heating temperature shows periodical changes, and I could easily distinguish certain repeated intervals of transformation. The approximative absolute temperature, T_n, of transformation, satisfies the relation $T_n = A \cdot n$, where A is a constant and n an integer number. This relation has been verified experimentally for iron from $n=3$ to 12, and for tungsten from $n=4$ to 9. The mean value found for A was for pure iron 97° and for tungsten 82°.

As remarked above, this phenomenon is most probably due to the quantum distribution of vibration energy. As the mean number of quanta of the atoms, however, increases continually with the temperature, I have assumed, to explain the periodicities, that the transformations occur at every temperature for which a certain fractional part $(1/r)$ of the atoms has a number of quanta like, or greater than, a new integer. This assumption gives $A = \theta/3 \log r$, where $\theta(=\beta\nu)$ is the characteristic temperature of the metal in consideration. From this relation r may approximately be calculated, though the values are, like those of θ, rather uncertain. I found for iron $r=4{\cdot}6$, and for tungsten $r=3{\cdot}3$. Thus the critical fractional part is about one-fourth, which seems to be a reasonable value.

G. BORELIUS.

Physical Institute, University, Lund.

Observation of Comets.

Dr. Crommelin in his valuable "Comet Notes," *B.A.A. Journal*, March 1922, p. 198, speaking of Reid's comet (1922 *a*), says "the comet must have been quite well placed for Northern observers last October and November, being of the 9th magnitude." It seems that Mr. Reid discovered the comet only a short time before it passed out of sight. This incident reminds us of the fact that a considerable number of these objects must escape observation altogether owing to the want of observers. It is remarkable that English astronomers appear hitherto to have taken little interest in cometary work, and that very few comets have been discovered from this country.

This is a regrettable circumstance. Yet the discovery and observation of comets include a comparatively easy and very attractive field of work open to amateurs with moderately powerful instruments. There are a great number of telescopic observers in the United Kingdom who have the means and the time at their disposal to accomplish valuable work in this department if they would only engage in it in an earnest manner. It is a branch which offers special inducements to amateurs, and holds out a greater prospect of brilliant success than perhaps any other sphere of labour. It is hoped, therefore, that some enthusiasts will turn their practical attention to it, for it is fair to suppose that some of them would like to follow in the footsteps of Messier and Pons, and the equally famous modern discoverers of comets, Barnard and Brooks.

The cometary section of the B.A.A. could not have a more capable director than Dr. Crommelin, and it would strengthen his hands, provide material for his researches, and repay him for his labours if the members of the section notified him of their discovery of one or two comets every year.

W. F. DENNING.

44 Egerton Road, Bishopston, Bristol.

A Proposed Laboratory Test of the Theory of Relativity.

I SHOULD like to comment on the assumption as to the atomic weight of RaG made by Dr. King in his letter in NATURE of May 6, p. 582. Instead of taking this as known, and calculating the atomic weight of radium by taking account of the α-particle, energy and electron masses, it appears to me that the reverse process would be more justified. It is true that there is an unexplained discrepancy in the difference between the atomic weights of uranium and radium, but we have no reason to doubt the value of the atomic weight of radium obtained by Hönigschmid. As his radium was obtained from Joachimstal pitchblende, which contains practically no thorium, there is no liability to disturbance from the presence of isotopes of radium in his material. On the other hand, the theoretical atomic weight of RaG was obtained by subtracting the mass of five α-particles from the atomic weight of Ra. That the lowest value (206·046) found by Hönigschmid for lead from Morogoro pitchblende agrees so nearly with the theoretical value (205·93), shows only that the amount of original lead present in this material was very small, although, of course, it gave splendid confirmation to the theory of isotopy. We cannot say, however, that we are dealing with *pure* RaG, even though we know that the amount of admixed isotopes must be very small.

In dealing with such small corrections to the atomic weight as are involved in Dr. King's letter, it thus appears unjustifiable to start off by assuming that the atomic weight of RaG is 206·00. As Dr. King suggests, however, when the technique of the determination of mass spectra has developed, we shall be independent of admixed isotopes, and the problem will then be put to a rigorous test.

ROBERT W. LAWSON.

The University, Sheffield.

Artificial Disintegration of the Elements.[1]

By Sir Ernest Rutherford, F.R.S.

Absorption Curves in Nitrogen and Aluminium.

The variation in the number of scintillations as the absorption in the path of the rays increases from 10 cm. is shown in Fig. 1. The source of α-rays is in

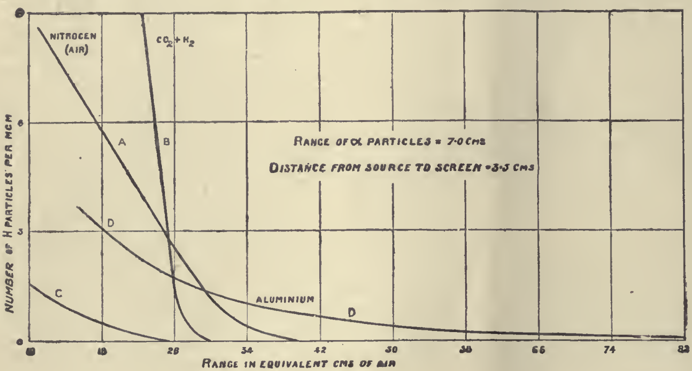

Fig. 1.

all cases radium-C. Curve A shows the effect in nitrogen (air) where the maximum range is 40 cm. Curve B is the corresponding absorption curve for a mixture of hydrogen and carbon dioxide, about 1 volume of hydrogen to 1·5 of carbon dioxide, which gives the same stopping power as air for α-rays. The number of scintillations due to hydrogen is very great in this case for absorptions less than 20 cm., but falls off rapidly, and none could be distinguished beyond 30 cm. Curve C gives the natural effect when the air is replaced by dry oxygen. This is small compared with that observed in nitrogen. Curve D shows the effect when an aluminium plate of 3·5 cm. stopping power is placed over the source and the air replaced by oxygen. Thus the particles liberated from aluminium are able to penetrate a much greater thickness than the particles from hydrogen or nitrogen.

It is a matter of great interest to find how the absorption curves for these long-range particles vary with the velocity of the bombarding α-particles. This has been examined for two typical elements, nitrogen and aluminium, and the results for the latter are shown in Fig. 2. It was found that to a first approximation the maximum range of the particles liberated from an element was proportional to the range of the bombarding particles. In all cases, the number of scintillations falls off rapidly as the velocity of the α-particles is decreased. The effect of velocity is specially marked in aluminium, and few, if any, particles are observed when the range of the α-particles is reduced to 4·9 cm. of air. The effect shown in curve D (Fig. 2) is due almost entirely to the "natural" scintillations from the source. When we remember that the decrease in velocity corresponding with the reduction of the range of an α-particle from 7 cm. to 4·9 cm. is only 11 per cent., we see how rapidly the number falls off with lowering of the velocity. It seems likely that no disintegration can be effected in the case of aluminium if the velocity of the α-particle falls below a certain critical value. This is not easy to prove conclusively, but, if correct, it indicates that the α-particle must have a certain critical energy to release an H-atom from the nucleus.

A very striking result was observed in the case of aluminium. It is to be expected that the liberated particles should for the most part be projected in the direction of the bombarding α-particles. Actually, it was found, however, that nearly as many were shot in the backward as in the forward direction. No evidence of such an effect was observed in the case of the nitrogen particles. The other elements have not yet been examined from this point of view, but we should expect an element like phosphorus, which gives

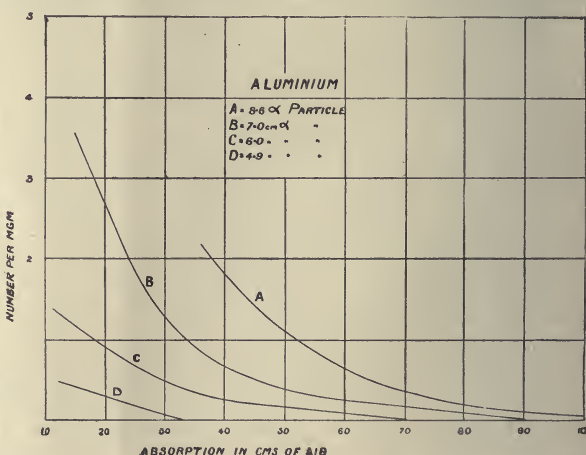

Fig. 2.

rise to long-range particles, to show a similar effect. A possible explanation of this striking result will be given later.

Nature of the Expelled Particles.

It can be shown readily that the long-range particles

[1] Continued from p. 586.

liberated from the elements are deflected by a strong magnetic field. By the adoption of special methods, it has been found possible to compare the amount of deflexion of these particles with that shown by the swift H-atoms produced when α-particles pass through ordinary hydrogen. It was found that the particles from nitrogen were deflected to about the same extent as the H-particles from hydrogen, and behaved in all respects like swift H-atoms carrying a positive charge. It seemed likely from the first that the corresponding particles from fluorine, phosphorus, and aluminium would also prove to be H-atoms liberated from the nuclei at speeds depending on the nature of the element and the velocity of the impinging particle. This has been confirmed in recent experiments by Dr. Chadwick and myself by a method similar to that employed for nitrogen. The bending of the particles in a magnetic field was determined for an absorption greater than 32 cm. of air, in order that the experiments should not be complicated by the possible presence of hydrogen contamination in the material under examination. The experiments were not easy on account of the small number of particles present under the experimental conditions and it was found necessary to devise a special microscope with a large field of view to carry out the investigation. The experiments were all in accord with the view that the particles from fluorine, phosphorus, and aluminium are swift atoms of hydrogen, and we may conclude that in each case an H-atom is liberated from the nuclei of these elements.

The maximum speed of ejection of the H-atom from the different elements can be estimated approximately by assuming that the law connecting the velocity and range of the α-particle holds also for the H-atom, namely, that the velocity is proportional to the cube root of the range. It has been calculated, and also confirmed by experiment, that the maximum speed communicated to a free H-atom by a head-on collision with an α-particle of velocity V is $1{\cdot}6V$, while its range in air is about 28 cm. Consequently, the maximum velocity of the H-atom from nitrogen, which has a range 40 cm., is $1{\cdot}8V$, and that from aluminium, with a range of 90 cm., $2{\cdot}37V$. The α-particle communicates 0·64 of its energy to a free H-atom in a direct collision, and it can be calculated that all H-atoms which have a range greater than about 56 cm. are projected with energy greater than that of the bombarding α-particle. In the case of aluminium, the maximum energy of the H-atom is 1·4 times that of the incident α-particle. This is a very interesting result, showing that in some cases there is actually a gain of energy as a result of the disintegration of the aluminium nucleus. We must therefore conclude that at any rate for all collisions in which the liberated H-atom has a range greater than 56 cm. of air, a part of the energy of the H-atom is derived from the disintegrated nucleus. This is analogous in some respects to the well-known gain of energy in the escape of an α-particle from a radioactive nucleus.

It must be borne in mind that the amount of disintegration effected by the α-particles is on an excessively minute scale. When a particle from radium-*C* passes through aluminium, it probably passes through the electronic structure of about 100,000 atoms, but only about two α-particles in every million get near enough to the inner nucleus to effect the liberation of an H-atom. We know that the collected α-particles from 1 gram of radium give rise to 163 cubic mm. of helium per year. If we suppose that all the α-particles from 1 gram of radium were fired into aluminium, the amount of hydrogen liberated by the disintegration of the aluminium nuclei could not be more than 1/1000 of a cubic millimetre per year. The amount of hydrogen liberated under possible experimental conditions is thus almost beyond the means of detection by ordinary chemical methods. It has only been possible to study the disintegration by the use of such a delicate method that each H-atom set free produces a visible scintillation on a zinc sulphide screen.

Mechanism of Disintegration.

From a study of radioactivity, it has been surmised that the α-particle or helium nucleus of mass 4 is one of the units of which the atoms are built up. The experiments referred to in this lecture gave the first definite proof that the hydrogen nucleus also is one of the units of the structure of some of the lighter elements. It is of interest to note that H-atoms are only liberated from elements the atomic masses of which are given by $4n+2$ or $4n+3$, where n is a whole number. Elements like carbon and oxygen, the atomic masses of which are given by $4n$, are not affected. This is shown in the following table :—

Element.	Mass.	$4n+a$.
Boron	11	$2\times4+3$
Nitrogen	14	$3\times4+2$
Fluorine	19	$4\times4+3$
Sodium	23	$5\times4+3$
Aluminium	27	$6\times4+3$
Phosphorus	31	$7\times4+3$

This result is to be anticipated if the nuclei of these elements are built up of helium nuclei of mass 4 and hydrogen nuclei. In order to account for the liberation of an H-atom from these elements, it is natural to suppose that the H-nuclei are satellites of the main nucleus. If the satellite is not too close to the latter, the α-particle in a close collision is able to give the satellite sufficient energy to allow it to escape from the system. It is to be anticipated that the H-satellites are closer to the nucleus in the case of aluminium than in the case of nitrogen, and that consequently more energy is necessary in the case of aluminium to effect their release. It is of interest to note that the chance of liberating a swift H-atom from nitrogen is not more than 1/20 of the chance of setting a free H-atom in corresponding motion. This indicates that it is probably only within certain prescribed limits of velocity of the satellite and position with regard to the central nucleus that the liberation of the satellite is possible.

We have already referred to the fact that the H-atoms from aluminium appear to be released in all directions. Actually, however, the velocity in the backward direction of the α-particles is distinctly less than in the forward direction. Such a result at first suggests that the α-particle acts the part of a detonator to the aluminium nucleus and that the energy of the escaping fragments is mainly derived from the nucleus. I think, however, that the following explanation is more probable and in better agreement with experiment.

If we suppose that the H-satellite is describing an orbit round the central nucleus, the direction of escape will depend on the relative position of the α-particle and nucleus at the moment of the close collision with the satellite. In the collision shown in

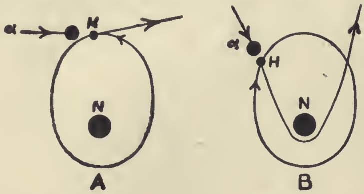

FIG. 3.

Fig. 3, *A*, for example, the H-atom will escape in the forward direction of the α-particle; in the collision (Fig. 3, *B*) the H-atom will describe an orbit round the nucleus and escape in the backward direction. The velocity imparted to the residual nucleus in the forward direction is much greater in the latter than in the former case. Such a view assumes that the forces between the positively charged satellite and nucleus are attractive instead of repulsive very close to the nucleus. This change of sign of the forces seems very probable at short distances from the nucleus, for otherwise it is difficult to understand how a positively charged complex nucleus can hold together.

Another consequence of some interest follows from the possibility of releasing H-atoms from light elements. It is generally supposed, although it is very difficult to obtain direct proof, that the helium nucleus is composed of four hydrogen nuclei and two electrons. In this combination there is a loss of mass, and this is ascribed to the very close combination of the structural units. On modern views of the relation between mass and energy, it follows that the energy liberated in the formation of a helium nucleus is more than three times the energy of the swiftest α-particle from radium. We should consequently not expect to be able to break up a helium nucleus with an ordinary α-particle, and this is in agreement with experiment so far as it has gone. In fact, the helium nucleus would appear to be the most stable of all nuclei.

Since, however, in the case of nitrogen, for example, we are able to release an H-atom by means of a slow α-particle, it seems clear that the H-satellite is not bound nearly so closely in the nitrogen nucleus as in the case of the helium nucleus. The change of mass due to the emission of energy in binding the H-satellite should consequently be much less than in the case of helium. The mass of the satellite should not differ much from the free H-nucleus of mass 1·0077 in terms of $O=16$.

If it be supposed that the nitrogen nucleus, for example, is made up of three helium nuclei of total mass 12 and two hydrogen nuclei, the mass of the nitrogen atom should not be exactly 14·00, but more nearly 14·01. In the case of the light elements, it appears probable that the effective mass of the protons composing the nuclei will vary in different atoms from about 1·007 to 1·000, depending on the closeness of the combination. Consequently, we should expect that the whole number rule found by Aston, which appears to hold for atomic masses to about 1 in 1000, would be departed from if measurements could be made with still further accuracy.

The next question which arises is whether any other particles beside that of hydrogen can be released by α-ray bombardment. Some time ago, I found that when radium-*C* was used as a source a small number of bright scintillations were observed, which had a maximum range in air of about 9 cm. It was natural at first to suppose that these were due to a new type of α-rays from the radioactive source. The effect, however, of aluminium screens in reducing the range of these particles led me at first to believe they were generated in the volume of the gases used, namely, nitrogen and oxygen. By comparing the bending of these rays in a magnetic field with that of H-particles from hydrogen, I concluded that they must be atoms of mass about 3 carrying two positive charges. Later experiments have brought home to me the untrustworthiness of this method of fixing the source of the radiation on account of the marked variation in thickness of films of metal foil. Using a more direct and simpler method, I have recently convinced myself that, at any rate in the case of oxygen, the particles have their origin in the radioactive source and not in the volume of the surrounding gas. Under such conditions, the comparative method of estimating the mass of the particles is no longer trustworthy. While a large amount of experiment will be required to fix definitely the nature of the radiation, the general evidence indicates that it consists of particles of mass 4, which are projected from the source and represent a new mode of transformation of radium-*C*.

By the methods outlined we can hope to detect only particles which travel a distance greater than the primary α-particles. If, however, a disintegration of an element should occur in which a massive particle is liberated, it is quite probable that the latter may have a range shorter than the α-particle. To examine cases of this kind, we can utilise the beautiful method developed by Mr. C. T. R. Wilson for showing the trails of ionising particles. Some experiments of this kind by a modified method have been made by Mr. Shimizu in the Cavendish Laboratory. A number of photographs showing well-marked tracks near the end of the range of the particle have been obtained. Until, however, these photographs are accurately measured up and compared with one another, it is difficult to be certain whether or not these branching tracks can be explained by collisions of the α-particle with the nuclei of nitrogen or oxygen. It seems clear, however, that the nuclei involved can travel considerable distances through the gas before being absorbed. If a large number of photographs be taken, it should be possible to settle definitely whether any collisions involving the disruption of atoms occur and to determine the probability of their occurrence. This direct method of attack of the problem, whilst laborious, should give very valuable information on this point.

It appears not improbable that the α-particle may occasionally be able to disrupt a helium atom from a complex nucleus like carbon or oxygen, which are believed to be composed of three and four helium nuclei respectively. The fact that the mass of these atoms is nearly an integral multiple of the helium atom suggests

that the helium nuclei are bound together with much weaker forces than the H-components of the helium nucleus itself. If the structure of the complex nucleus, say, of oxygen is such that the α-particle may communicate a considerable fraction of its momentum and energy to a single component, we should expect such disintegration to occur. It is also possible that charged particles of mass about 2 or 3 may exist as secondary building units of the complex nuclei of some elements, but so far no definite evidence of their liberation has been obtained.

I have so far confined my remarks to the disintegrating effects of swift α-rays, but it is important to consider whether the swift β-rays or energetic γ-rays from radium are able to produce any effect. We have found that neither β- nor γ-rays appear to have the power of giving sufficient energy to a free H-atom in ordinary hydrogen to detect it by the scintillation method, and consequently still less should we expect these rays to liberate a swift H-atom from a complex nucleus. It is possible, however, that these agencies, and particularly γ-rays of very short wave-length, may be able to liberate an electron and lead in this way to a change of its atomic number. Unless, however, the resulting atom is unstable and breaks up with the emission of a swift particle of the α-ray type, it will be difficult to be certain of such transformations. It should be noted that Slater has shown that α-rays are able to excite some very penetrating rays in their passage through ordinary matter. There is some evidence that such high-frequency radiation can only arise from the nuclei of atoms. If this be the case, it may be possible that the α-rays in some cases lead to a liberation of a β-particle from the nucleus and a consequent transformation. This effect, however, must be on a very small scale.

Many attempts have been made in the past to test whether the ordinary atoms can be disintegrated by special agencies. The late Sir William Ramsay, with the characteristic instinct for choosing the best line of attack, made a number of experiments on the effect of the α-rays of radium on matter and concluded that he had obtained evidence of the production of neon from water and the liberation of lithium from copper. These conclusions have not been confirmed by subsequent investigators, and in the light of the experiments described in this lecture it seems very doubtful whether the amount of transformation, even if it occurred, would be sufficient to be detected by ordinary chemical methods such as were employed.

Many instances have been recorded of the appearance of helium in discharge tubes, and it has been suggested that helium is a product of the transformation of the electrodes by the action of the intense electric discharges. The most notable experiments in this direction have been made by Prof. Collie, but the subsequent detailed investigations by Strutt did not confirm his conclusions. It is exceedingly difficult to prove that the appearance of helium is not due to its occlusion in the electrodes and liberation by the intense heating of the discharge. Similarly, many observations have been made of the steady liberation of hydrogen from electrodes. Winchester, who examined this effect in detail with thin aluminium electrodes, found that hydrogen was released until the electrodes were entirely dissipated. It is very difficult to believe that this hydrogen is a product of the transformation of aluminium when we remember the great energy of the α-particle required to effect it. As in the case of helium, it seems more probable that the hydrogen was originally absorbed in the electrodes.

While it is unsafe to be dogmatic on these points, the general evidence indicates that the atoms as a rule are such stable structures and the nuclei are held together by such powerful forces that only a most concentrated source of energy, such as the α-particle, is likely to be effective in an attack on such well-protected structures. Even when disintegration takes place, it is on an exceedingly minute scale, and only a few α-particles in a million are effective. If we had charged atoms available of ten times the energy of the α-particle from radium, we could probably penetrate the nuclear structure of all atoms and occasionally effect their disintegration.

Organisation for Visual Instruction.

By DR. C. W. KIMMINS, Chairman of the Cinema Education Committee.

A BULLETIN on the subject of visual instruction recently received from the University of Wisconsin is of great value as showing the remarkable results which have been obtained by the collection and distribution on an elaborate scale of material for the development of this method of teaching. The fact that in Wisconsin "the circuit plan of distribution" has been in operation for six years "with increasingly gratifying results," enables the authorities to speak with great weight on the subject. The Bulletin deals not only in considerable detail with every department of the organisation, but also gives valuable suggestions for overcoming difficulties such as the transport, storage, and repairing of films and lantern slides. An idea of the great importance attached to visual instruction by the University may be obtained from the fact that a room in the University extension building has been fitted up and equipped with stereopticons, motion-picture machines, and projection apparatus of many of the leading makes. Teachers and committees are invited to visit Madison at any time to inspect these machines side by side and compare their respective merits with one another. It is also possible at the same time to become better acquainted with the visual instruction plans and purposes of the university extension division as well as with the stock of material.

In the British Isles the useful part which visual instruction can play in educational methods has long been recognised, as is evidenced by the action of the more important local education authorities in providing the schools with lanterns, lantern slides, pictures, maps, diagrams, botanical and other specimens, and a variety of other material for this purpose. The Lantern Slide Committee of the London County Council has done valuable work for many years in the preparation of a magnificent collection of lantern slides suitable

for the illustration of lessons in various subjects. The catalogue of slides is frequently revised and ample provision is made for their distribution, of which full advantage is taken by the schools. The modern school, moreover, is generally equipped with a room, which is in constant use, specially designed for lantern illustrations. Thus, so far as the lantern is concerned, the schools have been generously treated.

The kinematograph film, however, is being used for educational purposes far more in America than in our own country. This is especially the case with adult education, in which the problem is an infinitely simpler matter than is that of the introduction of the kinema into the school for the normal purposes of instruction, in which a good case must be made for its value as against its competitor, the lantern.

There is no difficulty with propaganda films for various purposes, films dealing with general questions of health, those dealing with advanced science and specific industries, farming operations, general travel, and so on, provided always that they are prepared under the supervision of experts who are responsible for the sub-titles or captions. All are agreed on their value and great educational possibilities. They have, moreover, the advantage of being self-contained; each film tells its own, more or less complete, story. The difficulty begins when the film is used for continuous visual instruction in the general curriculum of the school.

The most promising feature of the situation as regards America is that the whole subject is being taken up by the universities, as is made abundantly clear by the Bulletin. The university extension division of the American university is a very important department, and being so intimately concerned with the extra-mural teaching of the adult, it comes into far closer personal touch with the schools than our own universities. The fact that in the Wisconsin experiment the majority of the films on educational subjects are edited by university professors is of far-reaching importance. The necessity for the collaboration of the expert and the film producer is emphasised in the Bulletin.

An admirable film was recently produced on a biological subject which would have much greater value and could be used with greater satisfaction if it were free from biological errors—errors that would not have crept in had its production been aided in and censored by men from the biology department of one of our universities. Illustrations could be multiplied almost indefinitely of films of the highest educational value that could be produced in the university and with the aid of the university staff.

What is generally known in this country as the educational film, suffers under the grave disadvantage of having to serve two purposes. It has to be of a sufficiently popular nature to be acceptable to the normal patron of the kinema theatre, and at the same time to contain sufficient material of scientific interest to appeal to the person who has a fair background of knowledge of the subject. To serve this dual purpose many beautiful films have been prepared at great cost to the producer, but they have not met with sufficient popular favour to stimulate the further production of this type of film. During the sitting of the Cinema Commission many teachers who appeared as witnesses said that the kinema might be used with great advantage in teaching such subjects as nature study and geography.

The difficulty of a dual purpose to be served has also been experienced in America, as is shown by the following extracts from the Bulletin:

(1) We therefore have two rather distinct classes of borrowers—the schools on one hand, calling for material to use in formal class-room work, and on the other civic and community organisations of many sorts, whose needs and desires differ from one another to a greater or less degree and in particular from the somewhat stereotyped needs of the schools.

(2) The class approach to the study of a topic through the aid of slides or motion-pictures should be essentially the same as a laboratory exercise in science. . . . In other words visual instruction should be reduced to a pedagogical method.

It will be seen by the above that whereas at present the ordinary educational film has only a limited usefulness in the schools in such subjects as nature study and geography, the more important problem of its value for normal school subjects by the production of a different type of film has yet to be solved. Many experiments are being made in the filming of well-known text-books and in the production of definite kinema text-books which may yield results of considerable value. Meanwhile, a very important original research is being carried out by distinguished experts in London, the report of which will soon be published and which will give much valuable information on some fundamental questions as to the relative value of the kinema and the lantern for teaching purposes.

There is, undoubtedly, in the kinema great educational possibilities, and the success of the important developments in visual instruction at the University of Wisconsin is a happy augury for the future.

Obituary.

ARTHUR BACOT.

ARTHUR BACOT, entomologist to the Lister Institute, died of typhus on April 12 at Cairo, where he was engaged in investigating the etiology of this disease and the precise method of its transmission through the agency of lice. His colleague Dr. Arkwright, working in the same laboratory, contracted the disease a few days later. His condition was the cause of grave anxiety, but he is now fortunately making a good recovery.

How they became infected is uncertain. They were occupied in experiments with lice that they had fed upon cases of typhus some time previously and had confirmed Nicolle's statement, hitherto unsupported, that the excreta of infected lice were capable of conveying the disease. Possibly they acquired the infection from such material. Experimental work upon typhus has already proved very costly, and Bacot's name is now added to the list of distinguished students, Conneff, Cornet, Jochmann, Luthje, v. Prowazek, Ricketts, Schussler, each of whom has fallen a victim to typhus while endeavouring to solve the problems of its etiology and epidemiology.

Bacot was born in 1866 and educated at Birkbeck

School. He did not enjoy the privilege of a scientific education, and on leaving school he became a clerk in a commercial house in the City, where he remained until forty-five years of age. Notwithstanding, his was a finely-trained scientific mind. Perhaps he was to the manner born. From boyhood he had been an enthusiastic entomologist, and despite his scanty leisure he became a lepidopterist of repute. Bacot was, however, no mere collector. Nor was he satisfied with observations and description of structure. It was the life history and bionomics of insects which attracted him and the use that could be made of entomology in the wider problems of heredity. He had an extraordinary knowledge of insects and a wonderful sympathy with them. Unfortunately his literary powers were slight, but his conversation on the subject of insect life was as fascinating as any of the writings of Fabre.

In the breeding of insects Bacot was extraordinarily successful, and some of the most important of his earlier contributions to entomological science were undertaken as studies in the laws of inheritance. Notable amongst these, which are scattered through the pages of the *Entomological Review* and the Proceedings of the Entomological Society, is his work with Prout "on the effects of cross breeding of different races of the moth *Acidalia virgularia*," which appeared in the Proceedings of the Royal Society, 1909.

The opportunity for Bacot to devote the whole of his energies to scientific work arose in the following way. The Commission for the study of plague in India having arrived at the conclusion that the essential means of spread of bubonic plague was the rat-flea, it was obviously advisable to obtain as much knowledge of the bionomics of these insects as possible. Bacot was invited to undertake the investigation. He was still occupied in clerical work, and at first he demurred on the score of both lack of time and lack of any special knowledge of fleas. His modesty was, however, overcome by the assurance that innocence of all but the external features of the siphonoptera was fairly general and the difficulty due to want of leisure was, to some extent, met by the provision of an assistant to carry out his instructions while he himself was at his office.

The results of eighteen months' work was highly satisfactory. The whole life history of the commoner rat-fleas was ascertained with great completeness, and the influence of all the significant environmental conditions upon their longevity and rate of propagation. The adverse effects of various treatments which might conceivably be used in combating plague were also determined. The observations formed the subject matter of a monograph on the bionomics of the common rat-fleas occupying 200 pages of the *Journal of Hygiene*. The work is a model of accuracy, clarity, and completeness, and at once stamped Bacot as an observer and experimenter of high quality.

The value of such a man to medical discovery was apparent, and in 1911 a special position was created for him at the Lister Institute, and he was invited to become its entomologist. He accepted the position, and henceforth was able to devote himself entirely to science and to apply his entomological knowledge and experimental skill to problems in epidemiology.

In the congenial atmosphere of the Institute, with well-equipped laboratories at his command, Bacot rapidly became expert with bacteriological and histological techniques, and was able to collaborate with his medical colleagues with completeness and to take a full share in the experimental work and in the responsibility for the results.

The Indian Commission had demonstrated fully that the agent of infection in the case of bubonic plague is the rat-flea, but the *modus operandi* it had been unable to determine. It was some years later (1913) that Bacot and Martin showed experimentally exactly how it occurred. From their observations, the very existence of plague seems to depend upon the accidental property of the plague bacilli of growing in the form of a coherent sticky mass. When the flea inflates its stomach with the blood of a plague-stricken rat, the bacilli, introduced with the blood, rapidly multiply in the alimentary canal, forming masses of culture. These masses increase quickly in size until they effectually plug the gizzard at the entrance to the stomach and grow forward in the gullet. A flea with its alimentary canal obstructed by this means suffers from a thirst which it is unable to quench, and bites with more persistence and much greater repetition than normally. The entrance into the stomach being obstructed, the efforts of the insect only inflate its œsophagus with the fresh blood, some of which runs back into the wound well dosed with plague bacilli, as soon as the action of the insect's pharyngeal pump ceases. What remains serves as culture media for plague bacilli to grow upon, and the result is, as Bacot was able to demonstrate by some wonderful sections, a flea contaminated, literally, up to its mouth. The plague bacillus passes no essential part of its life history in the body of the insect, such as is the case with the malaria parasite. It is an instance of spurious metaxeny, but a flea in the condition just described cannot fail to carry infection once it is let loose upon a susceptible animal.

In 1914 Bacot proceeded to Sierre Leone as the entomological member of a Yellow Fever Commission sent out by the Colonial Office. The original scheme of work was upset by the removal of the medical members owing to the war. Bacot, however, remained for one year and studied the bionomics of *Stegomyia fasciata*, the mosquito which is the transmitter of yellow fever, and produced a very complete and detailed monograph upon the life history of this insect in West Africa and the various conditions which modify its rate of propagation.

Bacot returned to England in August 1915 and at once threw himself into the intensive study of lice and the most practical method of ridding our soldiers of these vermin in view of their depredations and the incident dangers to health therefrom. The value of Bacot's work in this direction was great, and the experiments on which his conclusions were based were always made upon himself under conditions similar to those actually encountered in the field. The recommendations were soon found to be sound and practicable ones, and in 1916 he was asked to accept the position of honorary entomological adviser to the War Office. In this capacity he was constantly consulted by military sanitarians, who were bombarded with various nostrums and devices for dealing with the louse problem.

In 1915–16 our troops in France were found to be suffering from a new disease, "trench-fever," which soon proved to be a principal cause of medical invaliding.

McNee demonstrated that it could be transmitted from man to man by the inoculation of a small quantity of blood, and suggested that the usual manner of spread was by the agency of the innumerable lice infesting our soldiers. In 1917 a committee to study this new disease was appointed by the War Office with Sir David Bruce as chairman, and Bacot was invited to join as entomological member. The British Trench Fever Committee showed first that McNee's suggestion was correct and that this disease was transmitted by lice, a fact subsequently confirmed by the American Commission in France. In the course of their experiments Arkwright and Bacot confirmed the observation of Töpfer that minute pleomorphic bodies, of the order of magnitude 0·3 to 0·5 μ and somewhat similar to *Rickettsia prowazeki*, supposed by Rocha Limas and others to be the cause of typhus, were present in the gut of lice which had been fed upon patients suffering from trench fever. They failed to find them in lice with an unexceptional family history, brought up for generations by Bacot and nourished upon his own blood. Bacot studied the development of the little microbes in the gut of the louse day by day after its meal of infective blood, and he and his colleagues established that only lice in which these bodies were present were capable of transmitting trench fever. All attempts to cultivate the organisms have so far failed and the supposed causality of trench fever rests upon these observations of association.

Similar structures had been described by Ricketts and Wilder in 1910 in the gut of lice fed upon typhus fever cases, and later by Wolbach in the tissues of patients who had fallen victims to this disease. There was thus reason for supposing that the virus of both trench fever and typhus was of the same nature, and consisted of a new type of microbe which propagated in the tissue of the gut of lice and in the human body should it find access thereto.

Accordingly, when trench fever disappeared from this country, on the cessation of war, leaving many problems concerning it unsolved, Bacot turned his attention to typhus, as this disease presented analogies both as regards etiology and method of transmission. In 1920 he joined the Typhus Research Commission of the League of the Red Cross Society and went to Poland, taking with him a supply of his lice with a clean family history. He was responsible for the insect side of the investigation which, in view of the nature of the problem, was not the least important. The Commission, which has recently published its report, made many valuable observations. It was able to confirm under more rigid conditions of experimentation, earlier work which had been carried out in various parts of the world. The probability that *Rickettsia prowazeki* is the virus of typhus was thereby materially increased, but the labours of the Commission left the evidence resting upon association only.

In the course of work at Warsaw, Bacot accidentally infected himself with trench fever. Being in want of a further supply of lice for his experiments, he collected them from a public bath-house and nourished them upon his person. A sharp attack of the fever followed, and some of the insects were found to harbour the Rickettsia he and Arkwright had described in their work for the Trench Fever Committee two years previously. Afterwards, for some months, he was able to infect his clean stock of lice by feeding them on himself. Returning to London in the summer of 1920, with the collaboration of his colleagues Arkwright and Atkin, Bacot continued his endeavours to settle the matter of the virus of typhus. They were unfavourably situated in London to obtain a supply of typhus material. Consequently, when towards the end of last year an invitation came from the Egyptian Government to study the problem in Cairo, where typhus is endemic, the opportunity was welcomed. In company with Arkwright he proceeded to Egypt early in the year, and was soon installed in the excellent laboratories of the Department of Public Health, presided over by an old colleague, Dr. Charles Todd. The research was advancing with promise and his letters expressed enthusiasm regarding its progress. On March 24 he became ill and died on April 12.

Bacot had a passion for knowledge and a natural aptitude for scientific research. If the attainment of his quest promised to be of service to his fellow-creatures, this was an added attraction. He was well acquainted with the risks attending some of his work but, whilst never reckless, he was not a man to be deterred by danger from the pursuit of a useful inquiry. Its existence indeed appealed to a side of his nature which contributed to the charm of his personality.

His comrades at the Institute are proud of his attainments, but will rather remember him as a dear friend who was always helpful and was never known to be inconsiderate or unkind. C. J. M.

Louis Ranvier.

It must come as a surprise to many of the younger generation of biologists that Ranvier, whose name is immortalised in countless text-books, has but recently passed away. Born at Lyons in 1835, Louis Ranvier was attracted at the outset of his medical career to the study of histology, both normal and pathological. As concerns the minute investigation of the tissues, research and discovery were to all intents and purposes stagnant in France when the youthful Ranvier, full of indomitable zeal and unquenchable enthusiasm, devoted himself to the subject and determined that a study, the foundation stones of which had been laid by the great Frenchman, Bichat, should be worthily pursued. His early work was carried out in a small private laboratory which he equipped in the Rue Christine in Paris, where he and his friend Cornil not only taught the principles of histology to students but also produced, as a result of their joint efforts, the "Traité d'anatomie pathologique," a treatise which rapidly became classical.

Ranvier soon attracted the notice of Claude Bernard, who, recognising his great technical skill, enlisted his services for the College of France in 1867. He was soon put in full charge of a newly instituted Laboratory of Histology, where his reputation and fame grew so rapidly that a chair of general anatomy was created for him, into which he was installed in 1876. For a period of thirty years he was associated with the College of France, where he laboured with untiring zeal and where his most important discoveries were made.

The field covered by Ranvier's researches is exceed-

ingly wide. There is no tissue and scarcely an organ of the body which he did not investigate with characteristic thoroughness. Much of what is to-day sound knowledge of the structure of the connective tissues, glands, nerves, and nerve-endings, we owe to Ranvier. His discoveries in connection with the peripheral nervous system are perhaps the most familiar. It seems incredible that until Ranvier taught otherwise, a medullated nerve was thought to be a continuous tube. The term "nodes of Ranvier," by which he is best known, is most unfortunate. He described the interruptions in the contour of the medullated nerve as "étranglements annulaires." The term "node" is inexcusable and not to be condoned by its usage as an alternative in "constrictions or nodes of Ranvier," a solecism of which many writers are guilty.

Ranvier was not content with describing and delineating the minute structure of tissue or organ but ever sought to discover the functional interpretation of what he saw. Many of his investigations were to this end, and in this sense he must be regarded as the father of experimental histology. A master of technique, his manipulative dexterity was unequalled, and the laboratory practice of the present day is largely founded on his methods.

Ranvier's numerous writings are a model of clearness and exactitude. Never content with knowledge at second hand, he took such meticulous care to ensure accuracy that his statements are invariably trustworthy. His "Traité technique d'histologie" is undoubtedly the most original text-book on the subject ever written, and bears monumental testimony to his indefatigable energy and boundless resource.

Some twenty years ago Ranvier retired from a life of incessant labour to his country estate. Laboratory and scientific societies knew him no more; as he worked so he rested, revelling in the pleasures of a rustic life. Full of years and honour Ranvier passed peacefully away on March 22.

Current Topics and Events.

MUCH interest has been aroused by reports in the *Times* and other newspapers of the discovery of mummified animals in the Koster caves, 100 miles west of Johannesburg, South Africa. These caves are situated in a district in which numerous stone implements and other evidence of early human occupation have been found. They have therefore been carefully examined by Mr. Harold S. Harger, a well-known geologist, whose report is disappointing. It appears that the mummified remains occur in a thick layer of bat guano on the floor of the main cave, and represent only modern animals. It is not unusual to find such remains in the circumstances described, and there is one known case in Patagonia in which the skin and soft parts even of an extinct animal (a ground sloth) have been preserved. There is no doubt that the caves and surface deposits in the Koster district of South Africa are well worthy of the attention of the local geologists and anthropologists, but they have not hitherto afforded anything of special note.

A LARGELY attended meeting of physicians and others interested in mental hygiene was held in the rooms of the Royal Society of Medicine on Thursday, May 4, in order to inaugurate the new National Council for Mental Hygiene. The chair was taken by Sir Courtauld Thomson, who was afterwards elected first president of the Council. He communicated to the meeting a message of welcome from the National Council of Mental Hygiene of the United States, and expressed a hope that, by the establishment of the British Council, Great Britain would be able to take her proper place in the forthcoming international conference on the subject. He made a special appeal to laymen to join the new movement, so that they might co-operate with the medical profession in a common endeavour to improve the mental health of the country. Dr. Head insisted that mental hygiene is as important as sanitation, that mind and body are inextricably intermingled, and that no structural disease is free from mental change. We should have been spared, he believed, the recent exhibition of auto-suggestion in this country, if its people had been better educated in mental hygiene. Sir Leslie Scott alluded to the greater assistance needed by those administering criminal justice from experts in mental disorders. Other speakers included Sir Humphry Rolleston, Sir Frederick Mott, Dr. Farquhar Buzzard, Lord Southborough, Hon. Lady Darwin, Major-General Sir John Goodwin, and Sir Maurice Craig. The provisional committee was empowered to draw up a constitution and to elect an executive committee.

THE half-yearly council meeting of the National Union of Scientific Workers was held on Saturday, May 6, at the Caxton Hall, Westminster, Dr. A. A. Griffith, president, in the chair. The report of the executive committee was presented by its chairman, Prof. L. Bairstow, who mentioned the co-operation of the Union with the British Medical Association in regard to removing disabilities suffered by scientific institutions under the Key Industries Act, and with the Teachers' Registration Council on the subject of the danger of parsimony in education. Progress in the negotiations with the British Association of Chemists was reported, and a scheme outlined which it was hoped might be made the basis of an immediate temporary arrangement for joint working, to tide over the period until complete amalgamation could take place. Negotiations on behalf of members had been carried on with the Ministry of Agriculture, the Air Ministry, and the India Office, and satisfaction obtained on many points. The Union had also been in communication with the Inland Revenue Commissioners for the purpose of furnishing them with a typical schedule of expenses incurred by scientific workers in various branches of science with a view of obtaining definite rulings and further concessions. Report was made of the successful working of the Government Section committee, which had enabled members in the various depart-

ments to discuss their common problems and formulate a common policy, and resolutions were adopted calling for the formation of similar sections to represent members engaged in university and other educational work, and members in industry. The vacancy on the executive caused by the death of Dr. Lyster Jameson was filled by the election of Dr. J. Henderson Smith, of Rothamsted.

THE *Quest* with the Shackleton-Rowett expedition has arrived at South Georgia after a cruise in the Weddell Sea. Mr. F. Wild, who succeeded Sir E. H. Shackleton in command, gives a summary of the results of the voyage in the *Times* of May 5. As was anticipated, ice conditions in the Weddell Sea proved to be unfavourable this year. After leaving the South Sandwich group where Zavodoski Island, the most northerly point of the Traversey Islands, was explored and surveyed, a course was set eastward. The pack was entered on February 4 in lat. 65° 18′ S., long. 15° 23′ E. Two attempts to penetrate southward failed on account of heavy ice and the low power of the *Quest*. The positions reached were respectively lat. 69° 18′ S., long. 17° 11′ 30″ E., and lat. 69° 49′ S., long. 0° 1′ W., and mark approximately the points where Bellingshausen in 1820 was forced to turn back when seeking a route to the south. No new land was discovered by the *Quest* although the soundings indicated, as was expected, that it could not be far south of lat. 69° S. After the second failure to get south, the *Quest* turned westward across the Weddell Sea through heavy pack. The objective was Ross's "appearance of land" approximately in lat. 65° S., long. 44° W. This report, which dates from 1843, had never been actually disproved although subsequent expeditions to the Weddell Sea had made the existence of land in that locality extremely unlikely. The *Quest* was beset within 35 miles of Ross's "appearance of land," and escaped only with difficulty. There was no sign of land and the depth of the sea was 2446 fathoms. The *Quest* then sailed for Elephant Island and South Georgia. On April 18 the expedition was to leave for Tristan da Cunha, Gough Island, and Cape Town. The expedition has not succeeded in adding to our knowledge of Antarctic lands, but has done valuable oceanographical work. A line of soundings between South Georgia and the place where the pack was entered cuts across a practically unsounded region. The track across the Weddell Sea seems to follow the course of the *Scotia's* line of soundings in 1903.

IN the *Chemiker Zeitung* of April 15 it is announced that Prof. P. P. von Weimarn has been appointed Research Associate of the Imperial Research Institute of Osaka, Japan, and charged with the creation of a laboratory for research in colloids.

NOTICE is given by the Chemical Society that applications for grants from the Chemical Society Research Fund must be received, on the forms provided, on or before Thursday, June 1.

ON Tuesday next, May 16, Prof. W. Bulloch will begin a course of two lectures at the Royal Institution on "Tyndall's Biological Researches" and "The Foundations of Bacteriology." These are the Tyndall Lectures. The Friday evening discourse on May 19 will be delivered by Sir William Bragg on "The Structure of Organic Crystals."

APPLICATIONS are invited by the Salters' Institute of Industrial Chemistry, Salters' Hall, St. Swithin's Lane, E.C.4, for a limited number of fellowships, each of the annual value of 250*l.*, falling vacant in October next. Applications, with full particulars of training and experience, must reach the Director of the Institute before June 10.

THE Board of Trade has received formal notices of complaint that boric acid and metaldehyde have been improperly included in the lists of articles chargeable with duty under Part I. of the Safeguarding of Industries Act, and that gallic acid and "R" tannic acid have been improperly excluded from these lists. These complaints will be submitted to the Referee, and persons directly interested should communicate with the Assistant Secretary, Board of Trade (Industries and Manufactures Department), Great George Street, London, S.W.1.

THE list of papers bearing upon the zoology, botany, and prehistoric archæology of the British Isles, issued during 1920, which has been prepared by Mr. T. Sheppard and published in the Report of the British Association for 1921, is now available as a separate pamphlet. The list occupies fifty pages of close print and is divided into three sections, zoology, botany, and prehistoric archæology. In this form it should prove very useful to students and workers. The list of papers is very complete, and as a guide to the work done in the British Isles it will be invaluable to workers in systematic natural history and to those responsible for regional surveys. Copies may be obtained, we understand, at the offices of the British Association.

THE Zoological Society has acquired by purchase two reindeer from Norway for its collection. During March 157 additions to the menagerie were received, 61 by presentation, 20 deposited, 70 by purchase, 2 by exchange, and 4 born in the gardens. The most interesting of the new acquisitions are two tree porcupines from Canada, three Alpine marmots from southern France, and a black-gloved wallaby from W. Australia. An Indian kestrel from Darjeeling is new to the Society's collection. At the monthly meeting of the Society on April 19, thirty-five new fellows were elected and forty candidates proposed for membership.

THE celebration of the centenary of the Royal Astronomical Society will begin on the evening of Monday, May 29, with a Conversazione, to be held, by kind permission of the Royal Society, in their rooms, at Burlington House. The following morning will be devoted to an introductory address by the president, Prof. A. S. Eddington, one on the history of the society by Dr. Dreyer, and a biographical address, with portrait slides, by Prof. Turner. In the afternoon there will be a scientific meeting, at which associates of the society present will be invited to speak on their work. A dinner will be held in the

evening. On Wednesday, May 31, fellows and associates have been invited by the president and council of the British Astronomical Association to attend the meeting of the association, at Sion College, Victoria Embankment, and on Saturday, June 3, there will be a visit to Greenwich Observatory, by invitation of the Astronomer Royal.

EARL BUXTON'S comments, at the annual meeting of the Royal Society for the Protection of Birds, on the ways and methods of the modern egg-collector, have made something like a sensation in the ornithological world, focussing and expressing, as they do, a feeling of protest strong among the majority of bird-students against the wholesale and reckless collection of wild birds' eggs in clutches by certain "oologists." The text of that part of Lord Buxton's speech is published in the spring number of *Bird Notes and News*, from which it appears that for the purpose of so-called science the successive layings of certain birds for an entire season are sought in various parts of the country, by the collector and his agents, regardless of the comparative rarity of the species, and also, it would appear, of Bird Protection Orders. Lord Buxton's subsequent correspondence with representatives of the British Ornithologists' Union will appear in the Society's annual report. The pages of *Bird Notes and News* are doubled in number with the present issue, the first of its tenth volume and twenty-first year.

THE Bulletin of the South-Eastern Union of Scientific Societies announces that the twenty-seventh Annual Congress of the union will be held at Southampton, on June 14-17, inclusive. The new president, to be elected at the evening meeting of the first day, is Col. Sir C. F. Close, who will give an address on "Small Rivers as Sources of Power: with special reference to the River Itchen." Archæology, botany, geology, and physiology will be represented in the papers and lectures which will be delivered at the Congress, and the programme which has been prepared should prove a very comprehensive and interesting one. At a recent council meeting an Archæological Section of the union was authorised, and Sir Edward Brabrook, Dr. W. Martin, and Mr. H. Norman Gray were appointed to deal with its development, with power to act. The council has also authorised the formation of a Zoological Section, and the carrying out of the initial steps have been entrusted to Prof. E. B. Poulton, and Messrs. R. Adkin, H. J. Turner, and Stanley Edwards.

THE next International Conference of Pure and Applied Chemistry will be held at Lyons on June 27-July 2, and as usual a variety of topics of interest to chemists will come up for discussion. The former International Committee on Atomic Weights has now, in consequence of the recent work on isotopes, become an International Committee on the Elements, and the British representatives are Prof. Soddy and Dr. Aston; another committee is considering a uniform system of abbreviations and a third is dealing with the preparation of research chemicals. The Federal Council for Pure and Applied Chemistry has asked Mr. F. H. Carr to act as correspondent for this committee. Mr. A. Chaston Chapman is acting as correspondent, in conjunction with the Society of Public Analysts, in connection with a project for the standardisation of food analysis, and Dr. Mellor has been appointed to put forward the views of British chemists in relation to ceramic matters. Most countries which are represented at these conferences have a fund from which the expenses of the delegates can be paid. Great Britain is an exception, and the Chemical Society has in a very public-spirited manner agreed to pay the travelling expenses of two of the delegates from this country. Some other bodies should follow this excellent example in order that Great Britain may take an adequate part in the regulation of those chemical matters which are capable of international treatment. To meet together in foreign parts, making the acquaintance of chemists from divers countries and comparing notes, helps to advance knowledge. *Plurimi pertransibunt et augebitur scientia*, as the Vulgate puts it.

Our Astronomical Column.

THE PLANET MERCURY.—Mr. W. F. Denning writes that the most favourable time of the present year for viewing this object will occur between May 12 and 27. Mercury is rarely visible to the naked eye, and intending observers should utilise the present opportunity of catching a glimpse of the fugitive little object, which it is recorded always evaded the eyes of Copernicus. The planet will be at its greatest apparent distance from the sun on May 23 and will set about two hours after the sun for about a fortnight. It will be easily visible to the naked eye near the west-north-west horizon, at about 8.40 P.M. G.M.T. if the sky is clear in that region. Twilight will be very strong but Mercury may be seen with a rosy fluctuating light rather brighter than that of a first magnitude star. It may be easily identified, for the bright planet Venus will be not more than four or five degrees to the eastward, and situated to the left and above the smaller orb of Mercury.

ADVANCES IN ASTRONOMY.—The presidential address to Section A at the Durban meeting (1921) of the South African Association for the Advancement of Science contains a good *résumé* of the remarkable advances in stellar astronomy during the last half-century. The treatment is full and explicit, and includes Dr. Shapley's investigations on the globular clusters (not, however, the recent criticisms of his conclusions) and the remarkable results obtained with the Mt. Wilson interferometer, both in investigating close binaries, such as Capella, and in measuring the angular diameter of the giant red and orange stars.

Many personal details of the donors and the designers of the great American telescopes are given; as a contrast Airy is quoted as saying in 1832 that no public observatory existed in the United States. The address concludes by expressing the hope that the development of university education in South Africa will lead to a corresponding expansion of astronomical observation and discussion, and the conviction that such studies draw out all that is highest and best in the human intellect.

Research Items.

Mexican Archæology.—Since the days of the Spanish occupation, the neighbourhood of Mexico City has supplied a rich field for the exploration of the antiquities of the pre-Columbian period. The most important problem to be solved is the investigation of the strata showing the succession of cultures —the Archaic, Toltec, that is pre-Aztec or Teotihuacan, and Aztec. Some progress in this direction is outlined in a report by Mr. A. M. Tozzer, published in Bulletin 74 of the Bureau of American Ethnology. It is at present impossible to determine with exactness the demarcation between the Toltec and Aztec cultures, the inference being that the former flourished towards the end of the first millenium A.D., and their influence in Yucatan, at least, extended into the fifteenth century. The artifacts discovered belong principally to the Toltec culture, those of the Aztec period being few in number and relatively unimportant, while a few things which are clearly pre-Toltec or Archaic were encountered. It is interesting to record that the methods of scientific archæology are being applied to this area, with expectations of important discoveries in the near future.

Fossil Man.—The Trustees of the British Museum have just issued a third edition of the useful little "Guide to the Fossil Remains of Man in the Department of Geology and Palæontology in the British Museum (Natural History)." The guide was first prepared on account of the interest in the study of fossil man which had been aroused by the discovery of the Piltdown Skull, and, as an introduction to the specimens and casts exhibited, described the main conclusions bearing on the question of the evolution of man which are furnished by palæontology, geology, and anthropology. In the third edition, the later part of the guide has been rewritten and extended to include an account of the skull found in the Broken Hill Mine, Rhodesia, in 1921, and two plates giving four aspects of the skull have been added. The more remarkable features of the skull are briefly described, and the chief points in which it presents similarities to the anthropoids, Neanderthal man, and modern man are noted. As regards the question of antiquity, it is pointed out that the life of the southern hemisphere has been less progressive than that of the northern, and the discovery of primitive species of man in comparatively modern deposits was to be expected. After summarising the evidence it is concluded that either the accumulation of animal remains in the cave is modern compared with deposits left by palæolithic cave men of Europe, or the animal life of Rhodesia has changed more slowly than that of Europe.

Geology in New Zealand.—Prof. J. Park reviews the structure of New Zealand in the Transactions of the N.Z. Institute, vol. liii., 1921, a publication that includes several papers on geology. As seems usual in that enterprising and fortunate dominion, the illustrations are of very fine quality. Brother Fergus (M. J. Gilbert) describes the unconformable series of the Waikato Heads district, where an "older-mass" terminating in the post-Jurassic peneplain is capped by a "younger-mass" of undetermined Cainozoic age. Mr. J. A. Bartrum revises the geology of Great Barrier Island, which guards the Hauraki Gulf on the long promontory of the North Island; he has discovered a large area of delicately banded Cainozoic rhyolites, previously described as slates and sinter. Dr. C. A. Cotton's account of the warped land-surface near Port Nicholson, the harbour of Wellington, is written with a true geographic instinct.

The Galician Petroleum Industry.—On April 11, a paper on "Galicia and its Petroleum Industry," by Mr. Albert Millar, was read at the Institute of Petroleum Technologists, in which was embodied technical and economic information of interest and importance. The most important area at the present time is still that of Boryslaw-Tustanowice-Mraznica, this being the district of the largest producing wells during the last fifteen years. As is well known, however, there has been a steady decline in production latterly, both in this area and in Galicia as a whole. While this causes alarm in certain quarters, it has been the means of promoting the development of new fields, chiefly those of Hordyscze, Ratoczyn, and Opaka, in the Tustanowice district; deep drilling at Popiele and Jasienica, north-east of Boryslaw, has also been undertaken. The bulk of the oil, which is of high grade and has a paraffin base, has hitherto been obtained from Oligocene beds, together with a smaller quantity from Eocene deposits. The Cretaceous rocks, petroliferous in Western Galicia, are largely an unknown factor as regards their ultimate commercial value, as they have been penetrated only by a few wells in the main region, and the results were inconclusive. Many experts believe that water troubles will prove more formidable at the Cretaceous horizon than is the case in the younger sands. Unquestionably water is the greatest difficulty to contend with in Galicia, and the calamitous experiences at Tustanowice, where "200 ton" wells were rapidly watered, have done much to inspire misgiving as to future prospects. Emulsification up to, and in some cases more than, 20 per cent., has resulted in special methods being devised for separating the oil. Zuber believed this water to be the indication of exhaustion of the field, but later observers favour its localisation to Eocene sands. Gasoline extraction, started in 1914, has made much headway, 660,000 klg. being obtained last year, a record production for Galicia.

A New Method of Gauging the Discharge of Rivers.—The method of gauging discharge based on the principle underlying chemical hydrometry has been in use for some time. It depends on the liberation of a known quantity of salt in solution into the river at a known rate and the estimation of the amount of salt in the river some distance below the inlet of the salt solution. This method has been proved to give very accurate results, but its chief disadvantage is the cumbersome nature of the preparations involved, not to speak of the cost. In the Scientific Proceedings of the Royal Dublin Society for April, Prof. J. Joly describes a method of utilising the same principles which gives even more accurate results and is very economical in labour and money. Radioactive measurements can be made with great accuracy by a simple form of electroscope. In the place of salt, which has to be introduced into the river by the hundredweight, a few litres of a solution containing a trace of radium is sufficient. Prof. Joly proposes to use pitchblende dissolved in nitric acid and then diluted with water. The solution is fed into the river under constant pressure. The water samples when collected are conveyed back to the laboratory and stored in ordinary boiling flasks for ten or twelve days. The emanation is then boiled off into a small exhausted bulb, from which it is introduced into the electroscope. At the end of three hours the electroscope is read and the river discharge can then be deduced.

Science in Bohemia.

By PROF. BOHUSLAV BRAUNER, Bohemian (Charles') University, Prague.

THE years during the war and after were not very favourable to our scientific investigations. The grants for the scientific institutions were reduced by the late Austrian Government in the same degree as the prices of instruments, etc., increased; many a young man of science has left the High Schools and never returned again. We are now enjoying the fourth year of our liberty and independence, but our country was bled by Austria, so that in order to keep our liberty, which we owe to the magnanimous support (moral only, alas!) of the Allied Powers, our Republic had to start its life from the very beginning. Paper and printing became so enormously expensive that the two chief scientific societies, the Royal Society of Bohemia, founded in 1770, and the Bohemian Academy of Science and Art, founded 1890, are able to print only very short scientific communications.

FIG. 1.—Central Hall of the old University Library, Clementinum, Prague.

I beg, therefore, to place before English men of science a very condensed account of the most prominent papers published during the last few years by Bohemian men of science. (Our German countrymen publish their scientific papers in Germany or in Vienna—as before the war.)

ASTRONOMY AND ASTROPHYSICS.—With the 8-inch telescope of the Observatory of the University no important work can be done. Prof. Brauner refers to a communication published in NATURE of April 8, 1909 (vol. 80, p. 158), entitled "The Gases of the Ring Nebula in Lyra," in which he showed that of the four gases, separated by rotation as visible from Th. Wolf's spectra, the innermost gas ($\lambda=460$) must be lighter than hydrogen, whereas the outermost gas D ($\lambda=373$) will have a density between that of hydrogen and helium. We know to-day that the densities of the gases hydrogen and helium in nebulæ are proportional to their atomic weights. The line $\lambda=469$ in the gas A is now generally regarded as a line in the principal series of helium and identical with the line $\lambda=4685{\cdot}90$ obtained by Fowler by condensed spark discharge, but other helium lines, especially $\lambda=5876$ (10), are missing, and so the gas is called "protohelium." That the line $\lambda=373$ or $\lambda=3726{\cdot}1$ and $\lambda=3728{\cdot}838$ really corresponds to a gas heavier than hydrogen and lighter than helium was proved by Bourget, Fabry and Buisson, who found in 1914 that its density is 2·74, whereas Nicholson calculates 2·95.

METEOROLOGY.—After the Austro-Hungarian Empire went to pieces it became the duty of the young Czechoslovak Republic to establish an institute that would take charge in its territory of the stations that were previously under the agency of the Vienna and Budapest central meteorological offices. At the beginning of 1920 the Board of Education established the State Meteorological Institute (Prague II. U Karlova 3.), the first duty of which was to re-examine the list of the stations that suffered badly during the war. The central office is now running 120 stations, of which four are first-class observatories, Prague, Milešovka (mountain station, elevation 2550 feet), Brno and Stará Dala. To the central office more than 20 stations send their observations daily, and a report of these is dispatched by "radio" three times daily from Prague. Monthly reviews of the weather are published meanwhile for the whole Republic and the climatography of the country is being prepared. The credit for this important work is due to Prof. Hanzlík and Director Schneider.

PHYSICS.—This science does not possess any long tradition in Bohemia, for the first really modern physical institute was built by Prof. Strouhal—who is known for his work "On Steel" carried out with Prof. Barus forty years ago—only in the first decade of this century. His successor was Prof. Bohumil Kučera, whose early death in 1921 is lamented. His principal work was on radioactivity. This highly talented physicist, a good English scholar, was preparing a text-book on mechanics for English students. Prof. Posejpal is working chiefly on the dependence of the refraction of gases on their pressure. Prof. Macků, one of our best physicists, is studying the oscillation of 2 and 3 conjugated circles. Another promising young physicist is Prof. Žáček, who investigated the influence of the spark on the oscillation frequency and deduced a general formula for it. He has also done important work in radiotelegraphy. The professor of natural philosophy (theoretical physics), Záviška, has studied the theory of electromagnetic waves, especially their flexion on parallel ring-cylinders.

INORGANIC CHEMISTRY.—The war was very unfavourable to chemical investigations: coal was sent to Germany and we were freezing in our laboratories and lecture rooms. There was no gas-supply during the daytime, platinum, accumulators, copper apparatus, etc., were confiscated by the late Austrian

Government, and no foreign periodicals (except German) were admitted. Inorganic chemistry had no tradition until 1877, when Brauner showed the aims of modern inorganic chemistry: chemical (and later physico-chemical) investigations of elements with regard to their position in Mendelejew's Periodic System. A series of results obtained was published in the Trans. Chem. Soc. Lond. since 1881. During the war Brauner published a revision of the atomic weight of praseodymium which yielded the number $Pr = 140{\cdot}94$ with a material separated from cerium and lanthanum for the first time by direct methods (not fractionation). The value obtained agrees exceedingly well with that obtained by Baxter and Stewart in 1915, who found $Pr = 140{\cdot}924$, but were unable to remove cerium and lanthanum entirely.

A revision of the atomic weight of tin carried out by Brauner and Křepelka, and later on by Křepelka alone, gave the value $Sn = 118{\cdot}699$, agreeing exactly with that obtained by other authors. In conjunction with Th. W. Richards, Křepelka determined the atomic weight of $Al = 26{\cdot}963$ based on the analysis of the bromide, $AlBr_3$; this revision carried out at Harvard University is being continued in Prague on the chloride, $AlCl_3$.

Scandium was prepared by Prof. Štěrba-Böhm in a state of "spectral" purity (Hönigschmid found with this material $Sc = 45{\cdot}10$).

The close analogy between boric and aluminic acid has been shown by Dr. J. Heyrovský, who made a physico-chemical examination of solutions obtained by dissolving (amalgamated) aluminium in aqueous solutions of the hydroxides of the alkalies, alkaline earths, and of ammonium. He ascertained that the process in all cases is additive, consisting in the formation of a complex anion $Al(OH)_4{}^1$, provided that the cation is strongly positive. He also determined the basicity and acidity of aluminium hydroxide and its bearing on the electrolytic potential of aluminium. Aluminium must be regarded as the true "Ekaboron"; in the constitution of the above compounds, apparently pentavalent, it is really positively trivalent aluminium (4 + and 1 − = 3 +), as was explained by Brauner in his preface to a text-book of analytical chemistry.

ORGANIC CHEMISTRY.—Prof. Votoček, of the Bohemian Polytechnic High School, is continuing his well-known work on sugars and has analysed with Burda the sugar components of lichens.

ANALYTICAL CHEMISTRY.—Prof. Štěrba-Böhm and Vostřebal worked out an exact method for the quantitative determination of molybdenum as trisulphide, using an admixture of formic acid on account of its high dielectric constant.

For the analysis of minerals the result of Štěrba-Böhm and Rosický's investigation of the new mineral "ultrabasite," from Freiburg in Saxony, is important; "basic" sulphides of silver and lead preponderate over the "acid" sulphides of tin and germanium. It contains 2·2 per cent. of germanium; thus ultrabasite becomes the fourth known germanium-containing mineral.

ZOOLOGY.—Our most prominent investigator in this branch of science is Prof. František Vejdovský, of the Bohemian University, who finished during the war his life-work, "The Structure and Development of the Living Substance" (in English). This work contains many coloured drawings (illustrations), but owing to the want of the necessary means the author was hitherto unable to publish it.

Vejdovský's successor, Prof. Mrázek, is very active in the zoological investigation of Bohemia with special regard to the ecology of the lower animals in ponds and lakes.

SYSTEMATIC BOTANY.—Prof. Josef Velenovský, the chief of our school of systematic botany, who is well known for his leading work "Flora Bulgarica," has just published another great work, "Bohemian Mushrooms," 4 vols. 920 pp., Prague, 1920–1922, which is richly illustrated. In order to study all kinds of fungi growing in Bohemia, he lived for a series of summers in the chief big forests of our country. He finds, *inter alia*, that far more mushrooms are edible than is generally accepted, but there are some which are poisonous or edible according to the weather and season. From his institute a series of papers was published by Domin, Kavina, Schuster, Daněk, containing interesting morphologic, cytologic, etiologic, and phytogeographic studies.

Prof. Domin, also of Bohemian University, continues his plant geographical investigations, especially with regard to Australian plants and also the Alpine flora of the Tatra Mountains.

PLANT-PHYSIOLOGY.—In this department excellent modern work has been done by Prof. Bohumil Němec, who has published two recent text-books: "Introduction into General Biology" and "Plant-anatomy and Plant-physiology." He has also published a series of papers on the Cecidia of the Eriophylages, on the infection of root-tubercles of Ornithopus, and on the influence of centrifugal force on plant cells. It is known that he was the first to explain geotropism. It should be mentioned that from his school O. Vodrážka proved the presence of a special statolithic starch in the blossoms and sheaths of positively geotropic plants with nyclinastic motions. J. Peklo isolated a symbiotic bacteria (azobacter) from the mycetocytus of the plant-louse *Schizoneura lanigera*. The work of Vl. Ulehla on the analysis of lateral and negative geotropism of Pharbitis and its *rôle* in the climbing character, and also that on heredity of A. Brožek, who succeeded in obtaining a mosaic bastard from two pure lines of Monulus, and studied the case of a simple Mendelian heredity in blossom-patterns, should also be mentioned. E. Senft has described the *rôle* of slime-trichoms in germination. The object of other work in this institute is the physico-chemical investigation of plant-life and also its connection with the chemistry of colloids.

GEOLOGY, PETROGRAPHY, AND MINERALOGY.—These three have the best traditions of all sciences in Bohemia, for they were cultivated by the most prominent men of science since about 1800. The conditions of publication during the war and after permit only of printing special papers of a very limited extent in the Transactions of the Bohemian Academy or of reviewing articles in journals with a broader programme.

Of the geological formations in the Bohemian countries the best known are those which Barrande united under the title "Système silurien," making them classical territory in his gigantic palæontological work, "S. S. du Centre de la Bohême." To-day, putting those formations together under the designation "Barrandien," on account of a tectonic common to them, we distinguish them into a succession from the Algonkian to the Devonian.

The research of Barrandien hitherto done was principally palæontological; for the solution of stratigraphic and tectonic questions a petrographic knowledge of eruptive and sedimentary rocks and the conditions of their origin was wanting. During the last few years this work has been organised and carried out by Dr. František Slavík, professor of mineralogy and petrography in our University, with

his collaborators, for the lower horizons from the Algonkian to the Ordovician in their whole extent. Slavík and Prof. Kettner completed in a series of publications the older research of Slavík on the Algonkian; Kettner worked up in monographs the lowest Cambrian (layers of Žitec) and the lower siluric horizon of Krušná Hora from the point of view of the genesis of the sediments; Dr. Slavík, with Mrs. Dr. Slavík, has described the oolitic chamoisite ores, their sedimentary genesis and the circulation of phosphorus.

Numerous other papers on the Barrandien by Kettner, Kodym, Purkyně, now director of our State Geological Institute, and Prof. Woldřich, give detailed tectonic pictures of the single districts; Kettner and Kodym have proposed a change of Barrande's designation of the horizons which is in agreement with the recent results of their investigation.

Another formation which is extended over large areas in Bohemia and Moravia and richly divided is the Cretaceous formation. The detailed stratigraphy and facial change of this formation has been for more than thirty years the object of thorough studies by Čeněk Zahálka, who has published great monographs of the Cretaceous formation in Podřipsko, Středohoří and Eastern Bohemia, whereas the environments of Prague were in this direction investigated by his son, Břetislav Zahálka; special studies were made by Woldřich.

As regards the petrography and geology of plutonic eruptive rocks and crystalline schists, two territories were intensively studied within recent times: the Bohemian Forest and the granitic massive of Middle Bohemia.

The work of Sokol on the Bohemian Forest has yielded a basis for broader studies of the primary inhomogeneity of the magma.

The ore deposits were also intensely investigated, especially the gold-veins and beds of iron ores (Mrs. Dr. and Prof. Slavík, Kettner, Stočes).

In special mineralogy a series of crystallographic papers was published (Ježek on Johannite, Ondřej on the Bohemian quartzes, Rosický on the topaz and gypsum, Slavík on the lacroisite), and chemical papers (Šplíchal on the products of decomposition of the felspars, Rosický and Štěrba-Böhm on the ultrabasite).

GEOGRAPHY.—During the war this science centred round the "Bohemian Geographical Society," which, in spite of the difficult conditions, was able to issue its transactions in the "Sborník." Owing to the Austrian censorship political geography was very limited and chiefly physical geography was cultivated. The fall of Austria means, of course, a new era for our political geography. Prof. Daneš's studies on the population of the industrial districts of Bohemia and Prof. Dvorský's on Yugoslavia as well as his book, with a political programme, on the territory of the Czechoslovak people, are the prominent works in this branch. A great work was started in ethnography with the first volume of the "Ethnography of the Czechoslovak People" (editor K. Chotek).

The chief geomorphological works based on geology and tectonics are: Prof. Daneš's on the "Kras" (Kars) of Australia and Java, Absolon's on the Moravian "Kras" (Kars), Dědina's on north-eastern and Sokol's on western Bohemia, and Vitásek's on the upper Odra district. An interesting monograph on Czechoslovak earthquakes has been written by Koláček. The military geographical State Institute, founded at the beginning of the Republic, published a series of fine maps of our new state, both charts of large areas as well as special maps, 1 : 25,000 and 1 : 75,000.

Wheat Prices and Rainfall in Western Europe.

IN an article on "Weather and Harvest Cycles" in the *Economic Journal* of December last Sir William Beveridge gave index-numbers showing the fluctuation of wheat prices in each year from 1500 to 1869, and made a preliminary mathematical and arithmetical analysis of these figures with a view of discovering periodicity in the yield of harvests, which might be attributed to periodicity in the weather. In a paper read to the Royal Statistical Society on April 25, he has now given the results of a much fuller analysis, involving a test of the same figures by harmonic analysis, for the discovery of practically all possible periods between 2 and 84 years' length. The following is a summary of the paper.

The amplitudes for more than 300 trial periods altogether have been calculated for a sequence of about 300 years from 1545 onwards, while for a number of these trial periods amplitudes have been calculated separately for the first 150 years and for the second 150 as well. These are shown on a periodogram from $q=150$ (2 years) to $q=3\cdot6$ (84 years). Each of the apparent periods indicated by the periodogram is considered in the light of four tests of periodicity: namely, the test of intensity (that is to say, comparison of the actual amplitude with the expectancy); the test of changing signs (both the elements a and b being required by theory to change signs in the neighbourhood of a period); the test of continuity (that is to say, indicating the same period, with agreement of phase as well as length, in each half of the sequence); and the test of agreement with other records (that is to say, the discovery of a similar periodicity in rainfall, temperature, or some other meteorological element). Particular importance is attached to the third of these—the test of continuity.

The results of this analysis are summarised in a table showing some 20 apparent periods ranging in length from 2·2 to 68 years. These are arranged in four groups:—

(1) Periods the reality and persistence of which is beyond doubt, strong evidence from the analysis of wheat prices being confirmed by close agreement of first-rate meteorological evidence. This group includes the period of 2·200 years discovered originally by Mr. C. E. P. Brooks, and later by Mr. J. Baxendell in rainfall; the period of 5·1 years discovered by Mr. J. Baxendell in wind and rainfall and by Capt. D. Brunt in Greenwich temperature; and the period of about 35 years discovered in 1890 by Dr. Brückner in temperature, rainfall, and barometric pressure.

(2) Periods strongly indicated by the wheat prices but for which meteorological confirmation is, at present, weaker or lacking. This group includes seven periods of 5·671, 9·750, 12·840, 15·225, 19·900, 54·000 and 68·000 years. Most of these periods are relatively long, a fact which helps in explaining failure

to demonstrate them hitherto in meteorological records. For most of them some meteorological parallel can in fact be found.

(3) Periods for which there is good, but not first-rate, evidence both in wheat prices and in meteorology. There are four of these with lengths of 3·415 years, 4·415 years (traced by Mr. Baxendell in rainfall), 5·960 years (traced by various writers in barometric pressure), and 8·050 years (no doubt the same as the period to which Prof. H. L. Moore and others have directed attention).

(4) The fourth group includes periods, some of which no doubt have reality, but all of which present inconstancy of action, changes of phase or other puzzling features. These include periods of 2·735, 5·423, 7·417, 12·050 and 17·400 years in addition to the well-known eleven-year period of the sunspots, which reappears in wheat prices with much of its normal instability of character.

The large number of periods found is striking. On *a priori* grounds, however, there is nothing really surprising in the suggestion of so many separate periodicities in the weather. Comparison between the weather cycles indicated by analysis of wheat prices from 1550 to 1850 and the actual rainfall in the ensuing 72 years, 1850 to 1921, confirms the view that these periodicities are real and important. For the purpose of this comparison, 11 of the 13 cycles in the first three groups are combined by a simple graphic method, the lengths and phases taken being exactly those determined by harmonic analysis; the combined result is shown in a single "synthetic curve" and is compared with the rainfall at 24 stations in Western and Central Europe (*i.e.* roughly the same area as that covered by the wheat prices records). A very high measure of agreement appears between the synthetic curve derived from wheat prices before 1850 and the rainfall as actually recorded after 1850.

In particular, the synthetic curve shows depressions foretelling lack of rain (which, in the area under review, is generally beneficial to wheat) at each of the markedly dry years in the past 70, namely 1857, 1864, 1870, 1874, 1883–4, 1887, 1898, 1904, 1908–9, 1921. It shows peaks foretelling heavy rain in the rainy years 1852, 1866, 1872, 1876 (for 1877), 1906, 1912, 1916. The only important discrepancies are the failure of the synthetic curve to show peaks for the rainy years, 1860 and 1903, and a depression for the somewhat local, though severe, drought of 1893. In other words, the synthetic curve which, subject to certain reservations, could have been drawn in 1850, if then drawn, would have foretold nearly all the important droughts and rainy seasons of the next 70 years. The drought of 1921 stands out quite remarkably well.

In view of the inevitable errors in the simple hypothesis upon which the synthetic curve has been constructed, the very large measure of agreement obtained in spite of these errors is all the more convincing as to the substantial correctness of the results of the analysis. The question whether definite periodicities in the weather exist and can be discovered, must now be answered in the affirmative.

The two most interesting questions of all must still be left unanswered. The first is, what will be the weather next year and in the following years. As to that no prophecy is made at all; rather, the opportunity is taken of definitely withdrawing anything which might have appeared like a prophecy in the earlier paper. The author is not prepared to say anything as to whether 1923 will be wet or dry. The full mathematical analysis in many ways has confirmed the earlier conclusions, but in more important ways goes beyond them; the general result might be quite different. Trustworthy prophecy of general weather conditions on the basis of periodicities now demonstrated should become possible in the near future, but only after a far more elaborate investigation than it has yet been possible to make.

The second question is, as to the seat and the physical cause of the periods appearing in the weather. A further analysis of the economic data may be helpful in some directions, but for the most part, that is a question for astronomers and physicists and should be left for them to answer.

The Teaching of Natural History in Schools.[1]

PROF. HICKSON and the other distinguished zoologists who have drafted the memorandum referred to below are deeply and properly concerned at the general neglect of zoology as a school subject. They maintain that this science should serve as a means of introducing youth to many of the greatest problems of life, and they therefore express astonishment, which will be shared by many people, at the findings of the investigators of the Secondary School Examinaton Council on the subject of school natural history. This body, in a recently issued report, committed itself to the remarks that "very few of the candidates (for certain important school examinations) offer this subject (Natural History), and it seems very doubtful whether it is worth while to maintain it as qualifying for a Pass with Credit in Science."

The members proceeded to express the opinion that the principles of biological science can be better illustrated by means of botany. From this latter view the authors of the memorandum dissent vigorously, and although the arguments they use will not perhaps appeal to botanists, there can, we think, be no doubt that all fair-minded botanists will support their conclusion that the principles of biology cannot be taught without reference to the animal kingdom.

More is wanted, however, than vigorous protest against examiners' opinions. Zoology is a science of vast range and school time is already taken up with many subjects. It devolves on the teachers of zoology to show in detail the kind of zoological syllabus that can be put into operation in schools as a basis for zoological teaching. In the drafting of such a syllabus they would naturally consult those teachers who have succeeded in maintaining and popularising zoology in their schools. As a preliminary to such a useful piece of work it would be necessary for zoologists to make up their minds whether it would be better to give the school zoology mainly or exclusively a natural history bias, or to attempt to treat the subject experimentally. There are arguments in favour of either method, and it might be found possible to draft alternative courses. With carefully drawn detailed syllabuses to guide instructors, and with occasional University courses for teachers, it should not prove impossible to secure for natural history a place in the curriculum of every school.

F. K.

[1] "Memorandum on the Teaching of Natural History in Schools," prepared by the Zoology Organisation Committee at the request of the Committee of Section D, British Association, Edinburgh, 1921.

A Modified Octet Theory.

IN an interesting paper on electronic structures in unsaturated molecules, published in the Journal of the American Chemical Society for March, Mr. E. D. Eastman discusses multiple bonds in relation to the octet theory of atomic structure due to G. N. Lewis. It is assumed that the pair of electrons possessed by elements of the first period (except hydrogen), although usually not acting as valency electrons, and forming a shell persisting throughout the entire period of elements, may take part in the formation of outer groups of octets when it is otherwise difficult for these to be formed. The double bond is then pictured as one atom in which the central electrons have been drawn into the outer octet, joined by two electrons to another atom in which the normal arrangement is preserved. In cases of triple bonding the two inner electrons are assumed to have been drawn into the outer shell of two adjacent atoms, there being again two electrons held in common.

The arrangements are illustrated by the formulæ of ethane, ethylene, and acetylene, in which the symbols indicate nuclei and all outer electrons are shown as dots:—

$$\begin{array}{c} \mathrm{H}\ \ \mathrm{H} \\ \mathrm{H}:\cdot\ddot{\underset{\cdot\cdot}{\mathrm{C}}}\cdot:\cdot\ddot{\underset{\cdot\cdot}{\mathrm{C}}}\cdot:\mathrm{H} \\ \mathrm{H}\ \ \mathrm{H} \end{array} \qquad \begin{array}{c} \mathrm{H}\ \ \mathrm{H} \\ :\cdot\ddot{\underset{\cdot\cdot}{\mathrm{C}}}\cdot:\ddot{\underset{\cdot\cdot}{\mathrm{C}}}: \\ \mathrm{H}\ \ \mathrm{H} \end{array} \qquad \mathrm{H}:\ddot{\underset{\cdot\cdot}{\mathrm{C}}}:\ddot{\underset{\cdot\cdot}{\mathrm{C}}}:\mathrm{H}$$

Ethane. Ethylene. Acetylene.

Multiple bonds are apparently formed only by elements of the first period.

To meet the requirements of facts relating to stability, reactivity, and free rotation, the electrons of unsaturated octets are assumed to be held in equilibrium positions at greater distances from the nucleus than in the ordinary case, the transfer from the extended position to the usual ones liberating energy. No attractive force between electrons is assumed, and the electronic arrangement is taken as cubic, though subject to distortion. The structure of carbon dioxide is probably unsymmetrical, rather than the arrangement of three nuclei in line commonly assumed. The structures of the nitrogen and oxygen molecules are represented by the following symbols:—

$$:\ddot{\underset{\cdot\cdot}{\mathrm{N}}}:\ddot{\underset{\cdot\cdot}{\mathrm{N}}}: \quad \text{and} \quad :\cdot\ddot{\underset{\cdot\cdot}{\mathrm{O}}}\cdot:\ddot{\underset{\cdot\cdot}{\mathrm{O}}}:$$

Many chemical facts discussed in the paper should prove of interest to chemists, who cannot ignore the undoubted difficulties introduced by multiple bonds in the present theory of molecular structure.

University and Educational Intelligence.

BRISTOL.—The Vincent Stuckey-Lean scholarship in botany, tenable for one year and value 36*l.* with free access to the department of botany, is offered. Further information may be obtained from the Registrar, the University, Bristol. Applications for the scholarship must be received not later than Saturday, May 20.

LONDON.—The following lectures, which will be open to the public free and without ticket, have been arranged:—At King's College, a course of three lectures on Tertiary Igneous Action in Britain, by Dr. Alfred Harker, on May 17 and 31 at 5 o'clock, and on May 24 at 4 o'clock, a course of four lectures on The Development of the Head Muscles of Vertebrates, by Prof. F. H. Edgeworth, at 5.30 P.M., on May 22-25, and one lecture by Prof. J. F. Van Bemmelen, of the University of Groningen, on The Morphological Character of the Skin Pattern in Insects and Mammals, on May 17 at 5.30 P.M. At Birkbeck College, a course of three lectures on Recent Work with regard to the Influence of Soil Conditions on Agriculture, by Dr. E. J. Russell, on Fridays, commencing May 12 at 6 o'clock, and one lecture on Whorled Phyllotaxis, by Prof. J. C. Schoute of the University of Groningen, on May 11 at 5.30 P.M. At the School of Oriental Studies, a course of three lectures on The Idea of Personality in Sufism, by Dr. R. A. Nicholson, on Wednesdays, commencing May 17 at 5 o'clock. At the London School of Economics two lectures on Modern Views of Indo-European Origin, by Dr. Peter Giles, on Fridays, commencing May 12 at 5 o'clock.

THE following advanced lectures in medicine will be given in French at the Rooms of the Royal Society of Medicine, 1 Wimpole Street, W 1, at 5 P.M.: on May 22, "Anti-anaphylaxie," by Prof. F. Widal; on May 25, "De l'Érythrémie, (Maladie de Vaquez-Osler)," by Prof. H. Vaquez; and on May 31, "Des reflèxes de défense," by Prof. J. Babinski.

MR. W. H. REED, a former mayor of the city of Exeter, has purchased and presented to the Governors of the University College, Exeter, the mansion house of Streatham Hall and part of the Streatham Hall estate, to be used as the site of the University College of the South-west of England. The Governors have purchased the adjoining farm and lands so that the new College will enter into possession of a site of 120 acres. It is expected that the incorporation of the new University College, the establishment of which has been approved by the University Grants Committee, will be effected this summer. Streatham Hall is placed on rising ground to the north-west of the city. It is near the stations and conveniently situated in every respect. The estate is admirably laid out and commands a prospect over the Exe valley to Dartmoor. It is intended to place on the new site not only the College buildings but also the hostels and playing fields.

A CONFERENCE of representatives of universities of Great Britain and Ireland will (as we announced last week) be held at University College, London, on Saturday, May 13. The holding of such annual conference was resolved upon at the First Congress of the Universities of the British Empire, but, owing to the war, the realisation of this project was postponed although conferences for special purposes were held in the years 1917–1920. At the Second Congress of Universities of the Empire in 1921 the resolution in favour of annual conferences was re-affirmed and it was decided that the month of May would be a convenient time for holding them. All the home universities were invited to suggest agenda and from these suggestions the Standing Committee of Vice-Chancellors selected the subjects which appeared to be most suitable for discussion at the present time, namely, the urgent need for the provision of enlarged opportunities for advanced study and research in British universities, the increase of residential accommodation for students, specialisation in certain subjects by certain universities, and organisation of adult education as an integral part of the work of the universities.

THE Report of its Principal Officer on the work of the University of London during 1921–22 gives the following among other statistics for the three years 1913–14, 1920–21, 1921–22: total admissions of students, 3852, 6728, 7092; candidates for examinations (final) for degrees—1807, 1746, 2455 (external candidates only—907, 710, 912); names on the roll of internal students on May 1, 4888, 7870, 8758.

Hostel accommodation for students at King's College is being substantially increased, a grant of 12,000*l.* having been allocated to this purpose. Among noteworthy events of the year were the following: the opening of the Unit of Obstetrics and Gynæcology at the Royal Free Hospital for Women and of the Institute of Historical Research; the inauguration of professorships of history, central European history, history and culture of British Dominions in Asia, sanskrit, physics, and five medical school professorships; the institution of a Bachelorship in dental surgery and of a B.A. degree and diploma in Slavonic studies; the creation of a staff tutorship for University Extension Tutorial Classes; and the formation of a Union Society on the lines of those of Oxford and Cambridge. The report foreshadows the establishment, in close association with the University, of a central Post-graduate Medical School and Institute of State Medicine, a site for the purpose adjoining the University's Bloomsbury estate having been acquired by the Rockefeller Foundation which recently offered to provide 2,000,000 dollars for the furtherance of these objects. Arrangements were made during the year with the University of Paris for six members of the Faculty of Medicine to lecture in London, and six similar exchanges in various departments of science were arranged with four Dutch Universities. The report closes with an eloquent and stimulating reminder of present-day university educational aims.

THE council of the British Medical Association announces that an Ernest Hart Memorial Scholarship, tenable for one year, of the value of 200*l.*, for the study of State medicine, and three Research Scholarships, each of the value of 150*l.*, and tenable for one year, for the investigation of a subject relating to the causation, prevention or treatment of disease, are to be awarded. Grants in aid of research in these subjects will also be made. Preference will be given to members of the medical profession and to applicants who propose to undertake to investigate problems of practical medicine. Applications for scholarships and grants should reach the Medical Secretary of the Association, 429 Strand, W.C.2, not later than June 24 next.

THE Board of Education has just published a table of holiday courses which will be held in England and Wales during the coming summer (H.M.S.O. 6d). In addition to general courses for teachers at most of the centres, there are special courses in the following subjects:—biology, at Aberystwyth and Saltburn; practical geography, at Nottingham, Scarborough, Falmouth, Brecon, Barry, Bangor, Oxford, and Bristol; economic geology, at Camborne; mine surveying, at Camborne, Amman Valley, Cardiff, and Penarth; mechanical, electrical, and civil engineering, at Cardiff and Penarth; psychology, at Brighton, Derby, Nottingham, Repton Hall, and Bangor; science courses for teachers, at Cardiff, Barry, Penarth, Oxford, Weston-super-Mare, and Repton Hall; sociology, at Edinburgh; oceanography and fisheries, at Barrow-in-Furness; botany, chemistry, mycology, and entomology applied to everyday life, at Wye; and climatology and the relations between geological structure and agriculture, at Midhurst, the country hostel of the London School of Economics. In this course, Prof. W. T. Gordon and Dr. E. J. Russell will lecture; of the other courses, about half are being organised by various educational bodies and the remainder by local education authorities and neighbouring universities. The table gives the dates of each course, the fees, the principal subjects of instruction, the address of the local secretary, and other particulars.

Calendar of Industrial Pioneers.

May 11, 1830. Friedrich Albrecht Winsor died.—A native of Brunswick, Winsor settled in England about the end of the eighteenth century. He lectured upon the use of gas, in 1806 had an exhibition of appliances at 97 Pall Mall, London, and early the following year lit a part of that street with gas. This was the first street lighted in that way. He was connected with the Westminster Gas Light and Coke Company, and in 1815 went to Paris, where he died; there is a cenotaph to his memory in Kensal Green Cemetery.

May 13, 1883. James Young died.—The originator of the paraffin industry, Young was born in Glasgow in 1811, became an assistant to Thomas Graham, the chemist, and was then successively manager to Muspratt and to Tennant. Through a suggestion of Lyon Playfair, Young was led to the investigation of a petroleum spring at Alfreton, Derbyshire, and in 1850 took out a patent for the dry distillation of coal. Entering into partnership with Meldrum and Binney, he founded works in Scotland, where naphtha, lubricating oils, paraffin for burning and solid paraffin were produced.

May 13, 1884. Cyrus Hall M'Cormick died.—The son of an American farmer who had introduced various labour-saving appliances, M'Cormick began work on the reaping machine in 1831, three years later took out a patent, and in 1847 started a factory for manufacturing his machines in Chicago. It was afterwards said that owing to M'Cormick's invention "the line of civilisation moves westward thirty miles each year." Many honours fell to him, and he was made a corresponding member of the Paris Academy of Sciences as having done more for the cause of civilisation than any other living man.

May 14, 1852. Walter Hancock died.—A member of the family whose name is associated with the rise of the British rubber industry, Hancock was born in Wiltshire in 1799. Between 1824 and 1836 he made a large number of experiments with steam road carriages, in 1832 built the *Era* which ran between London and Brighton, and the following year constructed the *Enterprise* which ran between Paddington and the City.

May 14, 1915. John Samuel White died.—The founder of a well-known firm of shipbuilders and engineers at East Cowes, White was one of the pioneers of the fast steamboat for naval purposes. To increase the manœuvring power of his boats he brought out the double rudder system with the deadwood removed.

May 15, 1888. Charles François Hervé Mangon died.—A student of the École Polytechnique and the École des Ponts et Chaussées, Mangon, though originally employed on railway engineering, was best known for his works on irrigation and drainage and the application of science to agriculture. He held a chair in the École des Ponts et Chaussées, was a member of the Paris Academy of Sciences, and for a time was director of the Conservatoire des Arts et Métiers.

May 17, 1910. Philip Cardew died.—From the Military Academy at Woolwich Cardew passed into the Royal Engineers and afterwards specialised in the application of electricity to purposes of war. He was instructor in this subject at Chatham and became known for his inventions, among which were the hot-wire voltmeter and the vibrating transmitter for telegraphy. In 1888 he became the first electrical adviser to the Board of Trade. E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, April 10.—M. Emile Bertin in the chair.—E. **Borel**: Arithmetical definition of a distribution of masses extending to infinity and quasi-periodic, with average density zero.—I. **Fredholm**: An application of the theory of integral equations.—J. **Andrade**: The mechanical problems of regulating springs.—P. **Vuillemin**: A new species of Syncephalastrum: the affinities of this genus.—E. **Vessiot**: The conformal geometry of systems of circles.—M. **Janet**: The invariant canonical forms of algebraical and differential systems.—T. **Carleman**: Demonstration of a theorem of M. Borel.—A. **Myller**: Remarks on M. Carleman's note.—A. **Myller**: Some properties of ruled surfaces in connection with the theory of parallelism of M. Levi-Cività.—H. **Chrétien** and P. **Ditisheim**: An electrochronograph recording the time, in figures, to hundredths of a second.—M. **Sauger**: A remarkable coincidence in the theory of relativity.—MM. **Berloty** and **Combier**: The eclipse of the sun of March 28, 1922, observed at the Observatory of Ksara (Syria).—I. **Tarazona**: Observation of the annular eclipse of the sun of March 27-28, 1922, made at the astronomical Observatory of Valencia (Spain).—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the fourth quarter of 1921. Observations were possible on 76 days during the quarter. The results are given in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—H. **Chaumat**: An arrangement permitting the elimination and determination of the correction factor of wattmeters.—C. **Dévé**: The noise caused by aeroplanes. The pitch of the sound heard as an aeroplane is passing overhead varies according to the distance of the observer's ear from the ground, rising about two octaves when the ear is lowered to about eight inches from the soil. Possible causes of this phenomenon are discussed.—J. **Galibourg** and F. **Ryziger**: A method of recognising cultivated Japanese pearls. The hole usually drilled in the pearl for attaching to an ornament is utilised. A mirror is formed by placing a minute drop of mercury in this hole, the pearl is illuminated from the side and the structure examined microscopically. Differences between the natural and cultivated pearl are brought out in this way, and reproductions of photographs illustrating the differences observed are given.—P. M. **Monval**: The preparation of ammonium chloride. Determinations of the solubilities in saturated solution of sodium chloride, sodium carbonate, ammonium chloride, and ammonium carbonate, singly and in combination, the results being summarised on a Le Chatelier square diagram.—P. **Riou**: The velocity of absorption of carbon dioxide by alkaline solutions. A contribution to the experimental study of the ammonia-soda process.—C. **Chéneveau**: An application of the optical method of determination of the solubility of one liquid in another.—R. **Fosse** and A. **Hieulle**: The tendency of formaldehyde to form hydrocyanic acid by oxidation in an ammoniacal silver solution. Formaldehyde was oxidised in strongly ammoniacal solutions containing ammonium chloride and silver nitrate by a large excess of potassium permanganate. Working with 10 milligrams of formaldehyde in each experiment, a yield of 30-36 per cent. of hydrocyanic acid was obtained.—A. **Lanquine**: The direction and dislocations of the Cheiron strata to the south of the upper Estéron, up to the high valley of Loup (Maritime Alps).—A. **Guébbard**: Remarks on the last Provençal earthquake.—P. **Garrigou-Lagrange**: Great movements of the atmosphere and weather prediction.—E. **Gain**: The ultra-maximum temperature supported by the embryos of *Helianthus annuus*. If the seeds are gradually dried and heated by stages, with interposed periods of cooling, the seed can survive exposure to much higher temperatures than has been hitherto supposed. One lot of seeds submitted to this treatment gave 80 per cent. germination after a final exposure to 145° C., but this result was exceptional; another lot of seeds gave only 2-5 per cent. of germinations after the same exposure.—A. **Petit**: Concerning the "awakening" of arable earth. In a recent paper A. Lumière has pointed out the favourable effect on soil of a thorough washing with water. This washing acts as though it removed products opposed to the germination of seeds. The author directs attention to the fact that he published similar observations in 1909.—W. **Kopaczewski**: The differentiation of phenomena of shock by contact.—R. **Bayeux**: Maximum respiration at very high altitudes. An account of experiments on two subjects at Chamonix (1050 metres), the Vallot Observatory on Mont Blanc (4370 metres), and at intermediate heights.—W. **Koskowski**: Nicotine and the inhibitory nerves of the heart. Nicotine does not act on the heart by the intermediary of the pneumogastric nerve, but directly on the intracardiac ganglia.—J. **Mawas**: The lymphoid tissue of the spiral valve of the middle intestine of *Ammocœtes branchialis* and its morphological significance.—A. **Dehorne**: The muscular histolysis and phagocytosis in the cœlom of the Nereids at sexual maturity.—K. **Abrest**: The toxic index of illuminating apparatus, of heating apparatus, and of explosion motors. The ratio of carbon monoxide to carbon dioxide produced in any form of lighting or heating apparatus is termed the toxic index. This magnitude has been estimated for various forms of lighting burners and radiators, and in the exhaust of explosion motors.

Academy of Sciences, April 18.—M. Emile Bertin in the chair.—E. **Goursat**: The problem of the thrust of earth. It is shown that the partial differential equations of M. Boussinesq, modified by M. Remoundos, can be reduced to an integrable form.—E. **Borel**: Physical hypotheses and geometrical hypotheses.—E. **Ariès**: The maximum of the latent heat of evaporation.—G. **Valiron**: Integral functions.—E. **Belot**: The *rôle* of nebular media in the dynamics of stellar and planetary systems.—L. **Bull**: An apparatus for the rapid dissociation of images in kinematography by the electric spark. The film is stationary and the images, illuminated by electric sparks (at the rate of 50,000 per second), are received on a rotating total-reflection prism. The one disadvantage of the method is that the images are not parallel to each other from one end of the film to the other.—A. **Nodon**: The photogenic action of ultra-radiations.—E. **Darmois**: The action of acids on ammonium molybdo-malate. The polarimeter shows that this ammonium salt is very sensitive to the action of acids, and the diminution of the rotation appears to be proportional to the concentration of the hydrogen ions. The use of this method readily detects traces of sulphuric acid in vinegar.—A. **Braly**: A new method for the detection of gold and silver in minerals by means of the blowpipe.—A. **Schoep**: Soddite, a new radioactive mineral. This is a yellow crystalline mineral found associated with curite from Kasolo (Belgian Congo). It is a uranium silicate of the composition $12UO_3 . 5SiO_2 . 14H_2O$, and its radioactivity is in proportion to its high uranium content (86 per cent. UO_3). The name

soddite is proposed for the mineral.—J. **Thoulet**: Deep submarine volcanic eruptions. Evidence of submarine eruptions furnished by deep-sea soundings near the Canaries and the Azores.—R. **Souèges**: The embryogeny of the Rosaceæ. The first stages of the development of the embryo in *Geum urbanum*.—M. and Mme. F. **Moreau**: Mycelium with protuberances found in the Ascomycetes.—J. **Stoklasa**: The influence of selenium and of radium on the germination of seeds. Both sodium selenate and selenite exert a toxic action on the development of seeds, the latter possessing the most marked effect. This toxic effect is partially neutralised if radioactive substances are present at the same time.—R. **Argaud**: The intranucleolar presence of the centrosome.—A. **Lumière** and J. **Chevrotier**: Antityphoid vaccination by scarification. As an alternative to vaccination by the mouth, which as yet has not been fully accepted, trials have been made of a process of immunisation by scarification. This method is free from the troublesome reactions caused by direct injection, but the immunity conferred is not quite complete.—MM. **Cohendy** and E. **Wollman**: Some results obtained by the method of growth under aseptic conditions. Experimental scurvy. Infection of the aseptic guinea-pig by cholera.—L. **Corbière** and A. **Chevalier**: The origin of *Spartina Townsendi* and its *rôle* in the fixation of marine mud.

Diary of Societies.

FRIDAY, MAY 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.—J. Halm: A Method of determining Photographic Star Magnitudes without the Use of Screens or Gratings.—J. Halm: The Rotation of the Sun's Reversing Layer.—J. Evershed: Widened Lines in the Spectrum of Sirius.—A. Stanley Williams: Two Variable Stars in Gemini.—A. Stanley Williams: A Probably Variable Star in Gemini.—A. Stanley Williams: The Tawny Hue of Jupiter's Equatorial Belt.—A. N. Brown: Observations of RT Cygni (Ch. 7085) in 1917–22.—W. H. Steavenson: Observations of Nova Persei (1901) in 1921–22.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—S. O. Pearson and H. St. G. Anson: Demonstration of Some Electrical Properties of Neon-filled Lamps.—Dr. A. Griffiths and W. T. Heys: A New Apparatus for the Measurement of the Polarisation Capacity of Platinum Plates in Sulphuric Acid.—Dr. H. Chatley: The Molecular Forces involved in Cohesion.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Annual General Meeting.

JUNIOR INSTITUTION OF ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—L. A. Legros: Tanks and Chain Track Artillery.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. H. H. Dale: The Search for Specific Remedies.

SATURDAY, MAY 13.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. O. W. Richardson: The Disappearing Gap between the X-ray and Ultra-violet Spectra. I. Grating Results.

MONDAY, MAY 15.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—E. A. Reeves: The Evidence of a True North and South Directive Force in the Atmosphere.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.1), at 8.—Prof. T. P. Nunn, and others: Discussion on Prof. Whitehead's "Enquiry" and "Concept of Nature."

ROYAL SOCIETY OF ARTS, at 8.—F. F. Renwick: Modern Aspects of Photography (3) (Cobb Lectures).

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—J. A. Gotch: The First Half-century of the R.I.B.A.

TUESDAY, MAY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. Bulloch: Tyndall's Biological Researches and the Foundations of Bacteriology (Tyndall Lectures) (I.).

ROYAL SOCIETY OF MEDICINE (General Meeting of Fellows), at 5.

ROYAL STATISTICAL SOCIETY, at 5.15.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. F. Shepherd: Natural Colour Photography.

WEDNESDAY, MAY 17.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Dr. A. E. M. Geddes: Weather and the Crop-Yield in the North-East Counties of Scotland, followed by a general discussion on R. H. Hooker's Presidential Address, The Weather and the Crops in Eastern England, 1885–1921.—Dr. H. P. Waran: A New Form of Direct-reading Barometer.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—Annual General Meeting.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Annual Exhibition of Microscopic Pond Life.

THURSDAY, MAY 18.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. F. Keeble: Plant Sensitiveness (II.), To Contact and to Chemical Stimulation.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Prof. T. B. Wood and Dr. J. W. Capstick: The Progress of Metabolism after Food in Swine.—C. G. Lamb: The Geometry of Insect Pairing.—G. E. Briggs: Experimental Researches on Vegetable Assimilation and Respiration. XV. The Development of Photosynthetic Activity during Germination of Different Types of Seeds.—G. E. Briggs: Experimental Researches on Vegetable Assimilation and Respiration. XVI. The Characteristics of Sub-normal Photosynthetic Activity resulting from Deficiency of Nutrient Salts.—J. A. Gardner and F. W. Fox: The Origin and Destiny of Cholesterol in the Animal Organism. Part 13. The Autolysis of Liver and Spleen.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.—Annual General Meeting.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Sir Ernest Rutherford: Electricity and Matter (Kelvin Lecture).

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting), at 8.—P. H. Hardy and L. B. Harris: Electrical Equipment.

CHEMICAL SOCIETY, at 8, followed by an Informal Meeting.

FRIDAY, MAY 19.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—W. Rushton: Further Contributions to the Biology of Freshwater Fishes.—Prof. J. H. Priestley: Toxic Action of Illuminating Gas on Plants (with Demonstration).

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section) (Annual General Meeting), at 7.—A. H. Reeves: The Elimination of Atmospherics in Radio-telegraphy.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir William Bragg: The Structure of Organic Crystals.

SATURDAY, MAY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. O. W. Richardson: The Disappearing Gap between the X-ray and Ultra-violet Spectra. II. Photo-electric Methods.

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

FRIDAY, MAY 12.

LONDON SCHOOL OF ECONOMICS, at 5.—Dr. P. Giles: Modern Views of Indo-European Origins (1).

UNIVERSITY COLLEGE, at 5.15.—A. E. M. van der Meersch: Simplified Solutions for B.M. and S.F. Values for Rolling Loads (1);—at 5.30.—Prof. W. R. Shepherd: The Expansion of European Civilisation (2).

BIRKBECK COLLEGE, at 6.—Dr. E. J. Russell: Recent Work with regard to the Influence of Soil Conditions on Agriculture (1).

GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy (4) (Gresham Lectures).

TUESDAY, MAY 16.

UNIVERSITY COLLEGE, at 5.—Sir Arthur Shipley: Insects and Disease (3).

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Principle and Method of Hegel (3): The Philosophical Sciences.

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic (1) (Gresham Lectures).

WEDNESDAY, MAY 17.

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. R. A. Nicholson: The Idea of Personality in Sufism (1).

UNIVERSITY COLLEGE, at 5.15.—Dr. D. H. Scott: The Early History of the Land Flora (4).

KING'S COLLEGE, at 5.—Dr. A. Harker: Tertiary Igneous Action in Britain (1);—at 5.30.—Prof. J. F. Van Bemmelen: The Morphological Character of the Skin Pattern in Insects and Mammals.

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic (2) (Gresham Lectures).

THURSDAY, MAY 18.

UNIVERSITY COLLEGE, at 2.30.—Prof. W. M. Flinders Petrie: Recent Discoveries in Egypt (1);—at 5.15.—Sir Joseph J. Thomson: Atoms, Molecules, and Chemistry (3).

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Major-Genl. Sir W. B. Leishman: Enteric Fevers in the War.

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic (3) (Gresham Lectures).

FRIDAY, MAY 19.

LONDON SCHOOL OF ECONOMICS, at 5.—Dr. P. Giles: Modern Views of Indo-European Origins (2).

UNIVERSITY COLLEGE, at 5.15.—A. E. M. van der Meersch: Simplified Solutions for B.M. and S.F. Values for Rolling Loads (2);—at 5.30.—Prof. W. R. Shepherd: The Expansion of European Civilisation (3).

BIRKBECK COLLEGE, at 6.—Dr. E. J. Russell: Recent Work with regard to the Influence of Soil Conditions on Agriculture (2).

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic (4) (Gresham Lectures).

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SATURDAY, MAY 20, 1922.

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Imperial Aspects of Comparative Medicine.

THE Advisory Committee on Research into Diseases in Animals was appointed in November 1920 by the Development Commission "to report on the facilities now available for the scientific study of the diseases of animals, to indicate what extension of those facilities is desirable in the immediate future in order to advance the study of disease whether in animals or man, and to advise as to the steps which should be taken to secure the aid of competent scientific workers in investigating diseases in animals." The Committee comprised Sir David Prain (Chairman), Prof. O. C. Bradley, Captain W. E. Elliot, M.P., Sir Walter Fletcher, Sir William Leishman, Sir John M'Fadyean, Prof. C. J. Martin, and Mr. F. B. Smith, C.M.G. The report which has now been issued (H.M.S.O., 1*s*. 6*d*. net) affirms that the problem of disease and of health, whether in man, animal or plant, is in reality one, and that the acquisition of the greater part of our knowledge of human and of veterinary medicine, both curative and preventive, has resulted from the use of identical scientific methods. Moreover, the vast overseas trade of the United Kingdom in live-stock gives it a vested interest in the wealth annually at hazard from preventible causes throughout the Empire.

With this broad interpretation of its terms of reference, the Committee has had to deal with essentially the same problem as that of the Colonial Office "Committee on Research in the Colonies," to the report of which reference was made in the issue of NATURE for March 23, p. 365.

Whereas the Committee of the Colonial Office looked to the Universities as training grounds for future investigators, that of the Development Commission has concentrated attention on the Veterinary Institutions and Laboratories. It found that in the United Kingdom the only independent institution devoted to the investigation of animal diseases to which the name "Research Institute" could be applied was at the Royal Veterinary College, London. The aggregate State subsidy received by the five Veterinary Colleges during the year 1920–21 for research purposes totalled only 3696*l*. This condition of affairs renders impossible the proper payment of workers or the maintenance of laboratories or of field inquiries, and is stigmatised by the Committee as a national disgrace. In its survey of the facilities available overseas the Committee was embarrassed by the limited information at its command, but after excepting the Veterinary Laboratory at Onderspepoort on account of its valuable work for the Union of South Africa, the Committee adopts the dictum of the editor of the Tropical Veterinary

Bulletin that the state of research into animal diseases in the tropics is at present lamentable.

Affirming that the facilities available in the British Empire in men, laboratory accommodation and equipment, are totally inadequate for the interests at stake, the Committee recommends the gradual creation of a cadre of research workers under an advisory organisation of scientific experts. On both scientific and political grounds it is desirable that no demarcation should be drawn between research work in the United Kingdom and that in other parts of the Empire.

The Committee is of opinion also that, should financial conditions become less stringent, assistance from State funds would be justified towards the creation of one strong Institute to serve the needs of the United Kingdom and possibly of the Empire. In such an institute, research would be made into the comparative aspects of disease as a whole, and workers in different branches of the subject—veterinary, medical, botanical—would be brought into association.

It is unfortunate that the Committee terminated its labours before the announcement of the gift to the Government by the Rockefeller Foundation of two million dollars for the creation of an Institute of Imperial Hygiene in London. It is understood that the Government has already accepted the responsibility of providing staff and maintenance of the Institute when established. Moreover, the "Shakespeare Memorial" site adjoining the area recently acquired for the University of London has been purchased.

This new development must enhance profoundly the position of London as the post-graduate centre of the Empire. It is understood that the Ministry of Health favours the integration of certain activities of various bodies like the London School of Tropical Medicine with those of the proposed Institute. In view of the enormous advantages which would ensue to the whole science of medicine from the intimate association of research workers in human and animal disease, it is to be hoped that serious efforts will be made to meet the legitimate aspirations of the veterinary profession for better facilities for research and post-graduate study in connection with the new Institute.

The General Theory of Relativity.

Space—Time—Matter. By Hermann Weyl. Translated from the German by Henry L. Brose. Pp. xi + 330. (London: Methuen and Co., Ltd., 1922.) 18*s*. net.

PROF. WEYL'S work is the standard treatise on the general theory of relativity. It is the most systematic and penetrating book on the subject; it is also by far the most difficult. The reader must not expect a helping hand over difficulties which are merely analytical; only the barest indication of intermediate steps is given in passing from one formula to another. The book is not suitable for a first introduction to the mathematical theory; but those who have already acquired some familiarity with the methods and manipulations required will find here a deeper insight and a more general view of the logical coherence of the theory than is possible in more elementary text-books. We think too that Weyl, more than other continental writers, approaches the outlook natural to an English student. The subtle distinctions between the Cambridge and the continental schools survive the revolution which has overtaken scientific thought. Even with Einstein we feel a need to anglicise his mode of thought, and this is still more necessary with some other German writers. But Weyl strikes just the right note for us; and though he is often too far ahead for us to follow, we pay him the (perhaps doubtful) compliment of claiming him as one of our own school of thought.

In some branches of applied mathematics the analytical methods have obviously no connection with the physical processes. The lunar theory is a notable instance; we cannot conceive that the processes by which the moon finds out where it ought to be are in any way analogous to those by which the computer solves the same problem. It is part of the charm of Einstein's theory that the mathematical methods correspond step by step with physical processes, so that not merely the result but also the form of the analysis is significant. The deeper our comprehension of the mathematical tool (the tensor calculus) the deeper will be our insight into the structure of the world. There are perhaps some who cherish the hope that ultimately simpler mathematical methods of treating these problems will be devised; but even if this hope were fulfilled the simplification would cost us dearly. If to our minds it seems simpler to solve the problems of Nature for her by methods other than those which she herself follows, that only accentuates our unfittedness to comprehend her processes. In Weyl's treatment the physical significance of each analytical operation is most strongly emphasised.

A distinctive feature of Weyl's work is his use of the conception of tensor-density in addition to tensor. These differ by a factor $\sqrt{g}$. In any region of the world, we can always choose a system of co-ordinates such that $\sqrt{g}=1$ everywhere; from the analytical point of view the factor is a useless complication which can be omitted without loss of generality, so that tensors and tensor-densities become equivalent. But this computational simplification plays havoc with the physical significance of the formulæ. Intensity-measures and

quantity-measures become hopelessly confused. Weyl seems to have been the first to insist on keeping these distinct. He brings a meaning into formulæ which had previously appeared to be artificial combinations. The student who has with difficulty acquired some skill in operating with tensors has to learn in addition how to manipulate tensor-densities; but the results repay the extra labour.

Einstein has amalgamated for us geometry and mechanics. He has shown that if we have given an exact specification of the geometry of a region of space and time, that specification will also determine all the mechanical properties existing in the region—gravitational field, inertia, momentum, and stress. Einstein accepted for this purpose the geometry of Riemann. In 1918 Weyl showed that Riemannian geometry contains a limitation which makes it appear inappropriate to the description of a physical continuum from which all action at a distance is excluded. He generalised the geometry and so gave to the state of the world additional degrees of freedom. Actually four additional quantities had to be fixed in this more general specification of geometry; and he identified these with the four electromagnetic potentials. In this way the whole electrodynamic scheme is associated with the mechanical scheme, both being amalgamated with the geometry of the world. There is, however, an element of speculation in Weyl's unification which does not appear in Einstein's; the mechanical and geometrical properties of the gravitational field are aspects of the same phenomena; the electrical and geometrical properties of the electromagnetic field are not shown to be the same phenomena though they are supposed to originate in the same source.

Nearly half of Weyl's book is devoted to the development on a logical basis of a system of geometry. In this part we have to be content with laying a foundation, with scarcely a hint of the well-known phenomena of relativity which will follow. Knowing Weyl's great reputation as a pure mathematician, we felt some apprehension lest he should approach the study of space as though it were a matter of pure geometry. The fear was groundless. He recognises fully that he is dealing with a physical subject; and in his geometry space is recognised at the outset as a *form of phenomena* (p. 11), not a mere continuum of *n* dimensions. Among the most novel investigations is a justification of the Pythagorean metric (the quadratic formula for the interval) by an argument involving the theory of groups. The reasoning is difficult to follow.

As the changes made in successive German editions bear witness, Prof. Weyl is still developing his ideas. We think that near the end of the present edition he has reached conclusions which were not in his mind at the beginning. Four pages from the end, after some illuminating remarks on the two modes of transferring a quantity from place to place by "persistence" and by "adjustment" respectively, he decides that actual transference by clocks and measuring-rods corresponds to *adjustment*. Whilst this conclusion seems to be undoubtedly correct, the reader has scarcely been prepared for it, and indeed the existence of anything with respect to which adjustment can be made has only been demonstrated a few pages earlier. But the beginning of the book needs reconsidering in the light of this conclusion. How are we to reconcile the two following statements?

(1) The same object, remaining what it is, could equally well have been in some other place. The correspondence between the portions of space occupied in the two positions is called congruent transference (p. 11).

(2) A measuring-rod even in a statical field does not in general undergo a congruent transference (p. 308).

These are not the exact words, but I think that they convey the sense intended. It would seem to follow that a measuring-rod at another place and time is not precisely the thing it was. But it must be remembered that the statement (1) was enunciated as an axiom, which we were expected to accept as a matter of common experience; it is no place for metaphysical subtleties, which indeed Prof. Weyl is not likely to indulge in. There is, I believe, a direct contradiction between the initial premises (1) and the final conclusion (2) which can only be removed by revising our ideas as to the status of Weyl's ultra-Riemannian geometry. In spite of its specialised character the geometry of Riemann is the geometry of space and time ("the form of phenomena"), as Einstein assumed. Weyl's generalisation does not refer to actual space and time; but it gives us the needful mode of treatment in graphical guise of those fundamental relations which underlie the world of space and time and things.

Not until the last third of the book do we enter on the general theory of relativity. Then in a hundred pages we hasten through all the main results, including the re-formulation of mechanics to which Weyl has so largely contributed. De Sitter's and Einstein's rival views of a curved world are compared, and we gather that the author is not so hostile as most continental writers to the former. In either case, by noticing that $G^2\sqrt{g}$ (not $G\sqrt{g}$) is the fundamental scalar-density of zero dimensions, he is able to show that the cosmical curvature-term appears naturally and inevitably. Much of the more advanced theory depends on the Hamiltonian method of stationary variation of a volume-invariant. This is applied in two forms—

(1) Variations arising from changes of the reference-

frame vanish on account of the invariance. Equations so derived are mathematical identities which cannot be controverted.

(2) The vanishing of the variation for *all* small changes of the parameters is a possible form for a law of nature. Equations so derived rest on a particular hypothesis which challenges criticism.

We wish that the author had kept the results of these two applications distinct. We believe that most of the ascertained laws of physics are derivable by the first application, and the second is responsible for some additional results which cannot be tested and do not appear to us particularly probable.

The translator of such a book as this has our sincere sympathy. He has done a useful work which yet falls far short of complete success. There are many passages in the original which we have turned to again and again, and only very slowly grasped their meaning; others still defeat us. It was not to be expected that the translator would penetrate the thought behind them, and he has evidently given up the attempt to make his rendering convey any possible sense. We would not recommend any one to make a profound study of this work without having the German original at hand to consult when a difficulty is encountered. There are other mistakes harder to excuse. Weyl's treatment of space turns on the two conceptions of affine and metrical geometry, and it is impossible to proceed without mastering these. But the exposition of affine geometry on p. 18 refers continually to postulates I and II, and the reader will search in vain for any postulates so indicated. In the German edition a misprint of 1 for I is comparatively harmless; but in the English edition the further substitution of 2 for II extinguishes the reader's last hope of discovering what the argument refers to. On pp. 141-2, two axioms are printed as though they were headlines of the paragraphs following. Absurd mistranslations such as "mass of the earth" for "mass of the world" on p. 296 will probably not do much harm, though they shake our confidence. All the same, there is much good work in the translation, and those who are struggling to master Weyl's indispensable treatise will welcome the partial aid which it affords. A. S. E.

New Methods of Arctic Exploration.

The Friendly Arctic: The Story of Five Years in Polar Regions. By Vilhjahmar Stefansson. Pp. xxxi+784+plates. (London: Macmillan and Co., Ltd., 1921.) 30*s.* net.

NO such original and assertive explorer of the Arctic regions as Mr. Stefansson has appeared since Dr. Nansen startled the admirals by dispensing with a line of retreat. Mr. Stefansson's views are however, far more upsetting than those of Dr. Nansen, for he denies practically every theory and many reputed facts regarding the North Polar area, and contemns almost all the long-established methods of Arctic travel.

We cannot go on to Mr. Stefansson's vindication of his own powers as a pioneer without first deprecating his contemptuous tone with regard to arm-chair geographers and their views. Those harmless drudges do their best to follow the published narratives of explorers and to reconcile the contradictions between successive travellers' reports. If they say in their compilations that the Arctic Sea in its farther recesses is devoid of life it is because explorers have told them so, and if they dwell upon the hardships and dangers of Arctic explorations it is because earlier and less expert explorers did suffer and perish in the attempt to do, amid difficulty and pain, what proves easy and pleasant to Mr. Stefansson. We gladly acknowledge that Mr. Stefansson treats Peary as a great and successful explorer, and does full justice to McClintock's marvellous sledge journeys on the Franklin search; but he would have thought so much more of them if they had seen how easy it was to "live off the country"!

In pp. 30-32 much is made of the assumed ignorance on the part of Sir John Murray that sea-ice after long exposure on the surface of a floe can yield drinkable water. It seems to us that Sir John Murray probably controverted Mr. Stefansson's statement on this point not from ignorance but merely in order to test his character, for it was a common thing with Murray to see if a young man who knew something could be shaken in his confidence as to his own knowledge by the weight of an older man's authority. If Mr. Stefansson had wavered, as we are very sure he did not, Sir John Murray would have thought the less of him. As a matter of fact, we know that Murray was greatly impressed by the young Canadian's knowledge and fitness. With this book before them we are sure that the works of oceanographers and arm-chair geographers will henceforth be purged of some errors and fortified by many new facts; but the whole load of learning left by the old heroes of the North will not, on that account, be thrown into the sea like Stefansson's despised canned goods.

In 1913 the Canadian Government took over and financed an Arctic expedition which Mr. Stefansson had been organising in co-operation with the National Geographic Society of Washington and the American Museum of Natural History. These institutions withdrew their claims and so Stefansson's third Arctic expedition was purely Canadian. A great programme was prepared for work in two divisions, a northern in a

strong whaler, the *Karluk*, under Mr. Stefansson himself with a large staff and complete oceanographical equipment; and a southern for work on the coast of the continent under Dr. Anderson, who was second in command, and provided with a smaller vessel. The southern party proceeded on the whole according to plan; but the *Karluk* forced her way into the ice north of Alaska on August 13, 1913, and remained fast, drifting westward. On September 20, when the ship was ten miles off the land Stefansson thought it right to go ashore for a few weeks' caribou hunting; but the ship had disappeared when he was ready to return, and after quite old-fashioned difficulties and hardships, including the crushing and sinking of the ship, most of the men succeeded in reaching Wrangel Island off the coast of Siberia and were ultimately saved. Mr. James Murray, the biologist, and Dr. Mackay, both of whom had been with Sir Ernest Shackleton in the Antarctic, were amongst those who perished on the ice.

Ignorant of the fate of the *Karluk*, and deprived by her loss of all the carefully prepared equipment and trained assistants, Stefansson had to decide whether he should accept failure or put to a test his long-cherished idea of living on the resources of what he had come to look on as a friendly Arctic. He chose the latter alternative, found two old friends amongst the Arctic traders, named Storkerson and Andreasen, who were willing to take risks, got together some sledges and dogs, a few instruments, and a large quantity of ammunition, and on March 22, 1914, started on a great journey over the sea-ice from Marten Point in 70° N. No one on shore expected to see him again. A support party was sent back on April 5, when fifty miles from shore, and the three men with six dogs and provisions for thirty days marched northward over the floes along the meridian of 140° W. By May 5, they had reached 74° N. in 135° W., and seals and bears kept them in food and fuel in an eastward march until they landed on Banks Land on June 25, after travelling a thousand miles, never having been hungry, cold, or tired, and the dogs in better condition than at the start.

The summer was spent hunting and exploring in the unknown interior of Banks Land; the ship appointed to bring supplies arrived, and the winter over Stefansson started again north-westward over the sea-ice, reaching almost 77° N. in 130° W. early in May 1915. From this point he travelled due east to Prince Patrick Land, skirted its north-west coast, and to the north-east of it discovered a new land (Borden Island) in 78° N. 115° W., and the summer being then so far advanced as to make travel over the sea-ice very difficult he hurried back almost 600 miles by the west coast of Melville Island to his old base in Banks Land. Thence opportunity was taken of a chance trader, whose ship Stefansson purchased as a matter of course, to pay a brief visit to the comparative civilisation of Herschel Island, but on returning to Banks Land the party made an interesting journey eastward to visit the Copper Eskimos of Victoria Island. After wintering in Banks Land, Stefansson in the spring of 1916 made a journey across Melville Island to Borden Island, thence north-eastward to 80° N., where another new land, Meighen Island, was discovered in 100° W., and on his way back he found a third new land, Longheed Island, in 77° N. 105° W. The winter quarters for 1916–17 were in Liddon Gulf, Melville Island, classic ground of the Franklin search.

Early in 1917 Mr. Stefansson was again on his way north, this time along the eastern coast of Borden Island and onwards over the sea-ice almost to 81° N. in 110° W. Here his two companions, who were new hands on this occasion, broke down from scurvy, due to their surreptitious diet of tinned foods during the previous winter, and the most promising of all these wonderful journeys had to be cut short. The return journey reads like a sheer romance, and Stefansson well says that if Stevenson had only known of facts like these he would never have had to invent the plot of "Treasure Island." The accumulating interest of chapters 59 to 63 is tremendous, and will prove to most European readers a revelation of what is possible in Arctic America. On September 13 Stefansson landed from his stranded steamer at a little harbour in Alaska, and here his luck deserted him, for after planning another trip into the Beaufort Sea he was attacked successively by typhoid fever, pneumonia, and pleurisy, and 1918 was well advanced before he could leave the hospital in Fort Yukon, that nothing but his indomitable spirit enabled him to reach. His old friend Storkerson undertook an eight months' journey over the Beaufort Sea north to 74°, then drifting on a floe to follow the currents, and he returned safely, showing that he also could live on the natural bounty of the friendly Arctic.

We have given a condensed narrative, for the book is confused by digressions which obscure the sequence of events. The digressions, however, are full of interest, telling much of the habits of caribou, musk-oxen, seals, polar bears, and Arctic foxes, and more of Mr. Stefansson's own special subject—the habits and beliefs of the Eskimo, and the prejudices as to diet of all sorts of men and dogs.

The scientific results are being worked out at Ottawa, and we can refer here only to the unique value of the soundings taken by Stefansson and Storkerson in the Beaufort Sea. These determine the position of the Continental Shelf on several lines at right angles to

the coast of America and to the western islands of the Arctic archipelago. They also point to great possibilities in the way of more detailed oceanographical work by sledge journeys in the future.

HUGH ROBERT MILL.

An Epic of Science.

The Torch-bearers. By Alfred Noyes. Pp. lx+281. (Edinburgh and London: W. Blackwood and Sons.) 7*s*. 6*d*. net.

EPIC is perhaps too large a word to apply to this beautiful book, though Mr. Noyes himself suggests it in his preface. There is, as he says, "an epic unity—a unity of purpose and endeavour"—in the story of scientific discovery, and "the great moments of science have an intense human interest and belong essentially to the creative imagination of poetry." The world of science and of poetry, therefore, both owe Mr. Noyes a great debt of gratitude for his attempt—the first of the kind—to bring them together; and, apart altogether from the high scope which he announces, every reader who submits himself fairly to the influence of his verse will be carried away by the charm of the language, the human, sometimes humorous, touches of character, and the triumphs, mixed with pathos, of the story.

We are told in the preface that this volume is the first of a trilogy, though the subjects of the two which are to follow are not revealed. This one deals with the pioneers of astronomy, and the other two might well be given, one to the discoverers of physics and chemistry, ending in the marvels of the electrons, and the other to the story of evolution, linking the record of geology with the gradual establishment of the continuity of organic structure. These we shall await with intense interest, and with full confidence that Mr. Noyes will do justice to the broad outlines of the theme and its human bearings, without too much concern as to the absolute accuracy of his account in details. Of course there are mistakes here and there; Kepler's laws are not quite accurately given. But what a *tour de force* to present them at all, approximately and attractively, in poetic form! Of course, too, there are plenty of prose-like lines, about which some of the critics in the press have made merry. But at the most they are a very small proportion of the whole, far smaller than in any of the long narrative poems of Wordsworth.

Speaking of Wordsworth, it is a little strange that Mr. Noyes does not invoke his great authority in favour of his enterprise in this trilogy. He invokes Matthew Arnold, who prophesied forty years ago that poetry would carry on the purer fire of human thought and express in new terms the eternal ideas of faith and hope which must be the constant stay of the human race. But Wordsworth, in the Preface to the second edition of the "Lyrical Ballads," came nearer still to Mr. Noyes's idea. He showed how the Poet, being in that respect the Man, *par excellence*, looked always "before and after" and held our human ideals together. He carried everywhere relationship and love, and wove into the fabric of his vision all that mankind has ever done or known or dreamt. Thus the material of science is just as fit an object of the poet's art as any upon which it is more usually employed. "If the time should ever come when what is now called science, thus familiarised to men, shall be ready to put on, as it were, a form of flesh and blood, the Poet will lend his divine spirit to aid the transfiguration, and will welcome the Being thus produced as a dear and genuine inmate of the household of man."

More than a hundred years have passed since Wordsworth made that prophecy. The volume of the poetry written, either in this country or abroad, with that inspiration is but slight. Tennyson gave us some thoughts suggested by the doctrine of evolution, Matthew Arnold some others. On the whole, Sully Prudhomme has come nearest to Wordsworth's ideal of the poet inspired by science, but it takes with him the guise of a stern, sad doctrine of resignation and fortitude under inexorable laws. It remained for Mr. Noyes to strike a new note, of triumph in the growth of the human spirit, of patient search for truth, of romantic beauty in the linking up of relationships between the heavenly bodies, which have inspired the worship and wonder of man since he first looked upwards.

The figures Mr. Noyes has chosen for the protagonists of his drama have all some points of personal interest, as well as permanent importance in the building up of science. These personal aspects he rightly stresses. Copernicus is described upon his death-bed, waiting for the issue of his long-delayed work. Kepler is the fantastic poet, visited by Sir Henry Wotton, who quotes verse for verse. The trial of Galileo—dramatically the most effective thing in the poem—is given in the form of letters from his daughter Celeste and from others, friends and foes, somewhat in the manner of Browning.

It is tempting to quote some of the most telling lines in the poem; one reviewer, at any rate, has read some of them several times already. Two extracts only shall be given, not by any means as among the most beautiful, but as conveying the dominating spirit of the whole. The Prologue raises the question, is there

not one to touch
With beauty this long battle for the light?
The blind, blood-battered kings
Move with an epic music to their thrones,
Have you no song, then, of that nobler war?
. . . for, in these wars,
Whoever wins a battle, wins for all.

And then of Copernicus. The first effect of the new theory was to dwarf the importance of man, to make him "creep like ants upon our midget ball of dust, lost in immensity." But this is not the true or final issue:

This new night was needed, that the soul
Might conquer its own kingdom and arise
To its full stature.

F. S. MARVIN.

Biochemistry.[1]

Biochemistry: A Study of the Origin, Reactions, and Equilibria of Living Matter. By Prof. Benjamin Moore. Pp. vii + 340. (London: Edward Arnold, 1921.) 21*s*. net.

AS is pointed out in the preface, this book does not claim to be a general text-book of biochemistry. Hence, it is necessary, in the first place, to indicate the nature of its contents. The first two chapters are new; they deal with "biotic energy" and with the relation of life to light. There is much of interest and of suggestive thought for workers in that field of vital phenomena discussed in these chapters. The author's views on "biotic energy" are well known. We may note that, while being an independent form of energy, this is supposed to be quantitatively convertible into the "inorganic" forms of energy and to obey the laws of energetics. This being so, it is difficult to see what is gained by the assumption, unless it implies the function of a directing agency or "entelechy." Perhaps the author has in his mind something of the kind, since he speaks of "biotic energy" as *controlling* the chemical reactions in the living cell. A mild criticism may be made in this connection of the somewhat hazy and unintelligible nature of occasional statements in the book. This is doubtless due to oversight; but if one were able to attach a more definite meaning to certain expressions, it is likely that they might prove more useful than appears at first sight.

The following six chapters deal with photo-synthesis. They are practically reprints of the author's papers in the Proceedings of the Royal Society. While these experiments are of much interest, and will repay perusal, some doubt may be expressed as to the need for repetition of experimental detail, since the original papers are accessible elsewhere. With regard to the formaldehyde theory of carbon assimilation in plants, it may be remembered that Prof. Moore's experiments did much to give reasonable ground for holding this view, which has recently been made still more acceptable by the work of Baly, Heilbronn, and Barker. The assimilation of atmospheric nitrogen by the cell of the green plant under the influence of light, however, requires more convincing evidence than has been brought forward as yet.

The remaining chapters are reprinted and re-edited from "Recent Advances in Physiology" and "Further Advances in Physiology." The reader will be glad to have these articles again made available, but it is to be regretted that the opportunity was not taken to bring them more adequately up to date by correcting statements which no longer represent what is known on the subject. It may savour too much of "asking for more" if the opinion be expressed that readers would have been grateful for some account of the views of Langmuir on adsorption and catalysis, and of those of Bancroft on the latter. The application of the modern conception of "activity coefficients" to physiological phenomena is also a matter worthy of consideration.

Prof. Moore gives much destructive criticism of the assumption of a semi-permeable membrane on the surface of cells. It may be pointed out here that physiologists at the present day do not suppose such a membrane to be a permanent inert structure, but to be formed from the protoplasm in equilibrium with it and therefore liable to be affected by all kinds of functional change. Thus it becomes permeable in the state of activity of the cell, and most of Prof. Moore's arguments lose their weight.

There are certain interesting papers by the author which might well have been included in the present volume of reprints, such as those dealing with the osmotic pressure of colloids. This would have been a convenience to many workers.

When we find a section on the nervous mechanism of secretion amongst the questions dealt with in the book, we are naturally led to ask, what does the author understand by "biochemistry"? His biochemistry appears to be identical with what is properly called "physiology." The latter, however, as taught in the medical schools, is apt to be more or less limited to human or applied physiology, so that it was natural to institute a body of doctrine which should include the chemical phenomena of the lower animals and plants. But a complete physiological science includes these. Indeed, it is impossible to consider apart from one another the chemical and physical aspects of vital

[1] This review was written before the lamented death of Prof. Moore, the author of the work to which it refers.

phenomena. However convenient for practical purposes a separate department of biochemistry may be, it would be a matter for regret if this part of physiology became dissociated from the remainder. Indeed, it may safely be said that no physiological laboratory can carry on effectively any part of its work without the provision of a chemical department. Hence, biochemistry, as well as biophysics, must be included. What is needed seems to be the establishment of more chairs in what might properly be called "general" physiology, as distinct from "special" or human physiology. Since the term "general physiology" is sometimes misunderstood, and limited to the lower animals, perhaps the title of "biodynamics," suggested by the writer in another place, might be more appropriate. This name distinguishes the science of function from that of structure. Although, of course, one cannot exist apart from the other, such a separation is more scientific than that of the chemical from the physical departments of physiology, for the methods of both the fundamental sciences are needed for the proper investigation of vital problems.

At the same time, there may be said to be a more purely chemical branch of biochemistry, that devoted to the study of the properties of various compounds prepared from or by the living organism. This is really a special part of organic chemistry, and is obviously more related to the science of structure than to that of function, although it may conveniently be studied in connection with physiology. There is, however, an unfortunate tendency to call a man a "biochemist" who may be devoid of any acquaintance with vital phenomena. Another tendency, also apt to lead to confusion, is that of including pathological chemistry under biochemistry. This should surely be the chemical side of pathology, dealing with disease as physiology deals with normal processes. These remarks are not in any way intended to undervalue the pursuit of biochemistry, but as an attempt to make its position clear. Prof. Moore's book takes into consideration more than the chemistry of vital processes, so that the title is not altogether an appropriate one. W. M. B.

Morphological Aberration.

The Echinoderms as aberrant Arthropods. By Austin H. Clark. Smithsonian Miscellaneous Collections, vol. 72, No. 11. Pp. 20. (Washington, July 20, 1921.)

FOR some years past Mr. Austin Hobart Clark has been flirting with the idea that the Echinoderms were derived from the Arthropods, but we all pretended not to notice. Now that he has come into the open with a paper published by no less a body than the Smithsonian Institution, and that he has sent us a copy for review, we are obliged to reprobate such goings-on.

What Mr. Clark suggests is not merely such connection of the Echinoderma with the Arthropoda as others find with the Protochordata; he is "convinced that they are undoubtedly closely allied to the crustaceans, and especially to the barnacles." No one can have failed to remark some resemblances between crinoids and cirripedes, due to a somewhat similar mode of life: normally both are attached—whether by a stem or immediately sessile; the body is encased in plates, and from it project jointed and often branched appendages used for collecting food. It is not easy to gather precisely how much importance Mr. Clark attaches to these and other adaptive resemblances: we may give him credit for the statement that "there can be no question of any direct homology between" them, and confine him to the suggestion "that it is not impossible to regard them as parallel manifestations of the same ancestral appendicular plan." The trouble is that he will keep dragging in, not merely the highly specialised sub-class Cirripedia, but the most modified forms of that sub-class, thus:—"A combination of the asymmetry of the Verrucidæ [a geologically late family of cirripedes] (inherent also in very many other crustaceans, and especially noticeable in the Paguridæ and Bopyridæ [hermit-crabs and parasitic isopods]) carried to its logical conclusion in the complete atrophy of one side, with the modifications of the body seen in Sphærothylacus or Sarcotaces [problematic parasites] in a less extreme form, the roots of the Rhizocephala [parasitic cirripedes], and a skeleton formed after the manner of the plates in the shell of the Operculata [sessile barnacles of late origin], furnishes all the elements needed for recombination to form the crinoid." It is fairer to Mr. Clark to ignore these and similar comparisons of incomparables, and to consider only the fundamental parts of his argument.

The "outstanding features" of the echinoderms are, says Mr. Clark, "the presence of a vascular, a respiratory, and a superficial skeletal system, the last composed of articulated (calcareous) elements, the absence of gill clefts, and the sharp division of the body externally into (five radial) segments. In these features they agree only with the arthropods." Probably he means: "In the combination of these features." But, take the characters singly, and what is the resemblance? The so-called vascular system of echinoderms is most feebly developed and possesses no heart or other means of causing its contents to

circulate. The arthropods have a heart (except in some modified groups), a pericardium, and a large system of hæmocœlic spaces; the crustacea have definite arterial vessels. The arthropods, again, breathe by gills borne on the limbs or by tracheæ. But what Mr. Clark means by the respiratory system of the echinoderms is not clear: they aërate their body fluids in so many ways; such structures as papulæ, when developed, are not much like anything in arthropods. As for the crystalline skeleton of the echinoderms, deposited in the spaces of an interpenetrating mesoderm and resorbed as need arises, it can only be contrasted with the chitinous cuticle of the arthropods, hardened by the deposition of amorphous lime salts, and incapable of modification except through moulting. Lastly, how can the radial segmentation of echinoderms be homologised with the metameric segmentation of the arthropods? Mr. Clark does not tell us. He does, however, accept the general view that "the echinoderms are derived from bilaterally symmetrical ancestors," and he does later on quote Patten's hypothesis that the original metameres of the ancestor were suppressed on one side, and the remainder of the body bent round into a ring, so that the half metameres with their segmental organs became arranged in radiating lines—a hypothesis which places a very strained interpretation on the facts of embryology, and seems inconsistent with Mr. Clark's own views as to the relations of larva and adult.

No one would wish to assert that a study of the development and mode of life of the cirripedes can have no bearing on the origin of the echinoderms. There is much that is suggestive in the comparisons drawn by Patten and by Clark. But if those writers mean to conclude that the echinoderms were derived from the cirripedes by way of the crinoids, then assuredly they have been misled by adaptive resemblances. If they mean only that these resemblances imply a likeness of ancestral material no less than a likeness of external conditions, then we must ask them to indicate the connection between the ancestor of the Crustacea (nauplius-, Apus-, or trilobite-like, as they choose) and the bilaterally symmetrical ancestor (Dipleurula or what not) of the Echinoderma. It is quite possible that there was a primitive group of cœlomate animals from which the early echinoderms and the chætopod ancestors of the arthropods both arose; but to imagine that the arthropod type, once evolved on the "appendicular plan," as Mr. Clark calls it, retraced its steps towards anything that could have become an echinoderm, is contrary to all ascertained principles of evolution; and the alternative dream, that an arthropod, once recognisable as such, could progressively change into an echinoderm, is a baseless and unsubstantiated vision.

Mr. Clark will not, it is to be hoped, think we dismiss him in summary fashion. Many will say we ought to have done so. But there is a reason for treating the matter seriously. Any one has a perfect right to discuss the origin of the echinoderms and to maintain what views he pleases. Mr. Clark, as a distinguished authority on one class of echinoderms, certainly may claim a hearing. But whoever discusses morphological problems should have regard to the recognised principles and methods of morphology. He should have a sufficiently wide knowledge of comparative anatomy to be able to estimate the relative values of the facts that he adduces. There is at the present time a real danger that this discipline may be forgotten in the rush after alluring discovery in genetics, biochemistry, and other novel branches of biology. Among many examples of loose thinking in morphology, this of Mr. Clark occupies a bad eminence, exaggerated by the place of its publication and by the high merit of its author in his own field.

F. A. BATHER.

Physics for Students.

(1) *An Outline of Physics.* By L. Southerns. Pp. xv + 202. (London: Methuen and Co., Ltd., 1920.) 6*s.* 6*d.*

(2) *General Physics and its Application to Industry and Everyday Life.* By Prof. E. S. Ferry. Pp. xvi + 732. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 24*s.* net.

(3) *Laboratory Projects in Physics: A Manual of Practical Experiments for Beginners.* By F. F. Good. Pp. xiii + 267. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1920.) 9*s.* net.

(4) *An Introduction to Physics for Technical Students.* By P. J. Haler and A. H. Stuart. Pp. 240. (London: Library Press, Ltd., 1921.) 4*s.* 6*d.* net.

(5) *Experimental Science.* 1, *Physics.* By S. E. Brown. Section 5, *Light.* Pp. vii + 273-424. (Cambridge: At the University Press, 1920.) 6*s.* net.

(6) *Elements of Natural Science.* By W. Bernard Smith. Part 1. Pp. viii + 207. (London: Edward Arnold, 1921.) 5*s.* net.

(1) MR. SOUTHERNS has faced the difficulty, which many university lecturers have experienced, of providing a course in physics for college students in their first year. Not only are there great differences in the preliminary knowledge with which the students are equipped, but also different groups—say, engineers and medicals—look at the subject from very different angles. The first year should be a year

of inspiration. Broad outlines should first be presented in an elementary but scientific manner. Part 1 of this book, which is intended to be used in conjunction with a theoretical text-book, aims at giving such a general sketch in which new knowledge is incorporated as an essential part of the course. Part 2 comprises a course of laboratory work suitable for general purposes. In an interesting preface Mr. Southerns has some suggestive observations as to the methods of dividing students into classes, with the view of allowing the better students to undertake more advanced work. Such subdivision is advocated in connexion with both tutorial and practical work. The book has been well thought out, and may be recommended to teachers who have similar problems to solve.

(2) In this new volume Prof. Ferry, who is known as the author of a useful handbook of practical physics, has placed teachers of physics under fresh obligation by providing a text-book for college students "in which especial emphasis is laid on the diverse relations of physics to Nature, agriculture, engineering, and the home. Much of the motivation and illustrative material has not appeared heretofore in any text-book." Even if we do not fully grasp what is implied by the term "motivation," we may admit the general accuracy of this claim. A lecturer on physics in search of novel or up-to-date illustrations should certainly consult this volume. By studying the series of kinetoscope photographs of a freely falling cat and the accompanying letterpress he will learn why the cat alights on its feet. "The recent war has produced many highly important and interesting devices, some of which are here presented to students for the first time." We find, for example, descriptions of acoustic goniometers, based on binaural hearing, for locating invisible submarines and aeroplanes, and of the "radio-compass," by means of which the position of a vessel at sea may be found by wireless signals.

The amount of information that has been packed into these 700 pages is remarkable. But it must not be supposed that this is merely a popular or descriptive book; it is a scientific treatise, and every page bears evidence of the fact that it is the work of one who has considered with care the theory of each subject and the best method of presenting it to the student. A few points of interest may be mentioned. For the familiar "latent heat of fusion" the term "heat equivalent of fusion" is suggested. The paragraph dealing with the black-body temperature scale seems to us to make a simple matter complicated by its treatment of "the black-body temperature of a non-black body." There seems no good reason for speaking or thinking of this as the temperature of the non-black body itself; it is simply the temperature of a black body which emits radiation at the same rate. Electric resistance is discussed before electromotive force or Ohm's law, being measured by the amount of heat developed in a conductor by the passage of unit current for unit time.

There are interesting chapters on the electron hypothesis (including a description of the three-electrode vacuum tube) and on electromagnetic waves. The section on light is excellent; the cardinal points and the aberrations of lenses and lens systems are well treated, as also are various optical instruments. Physical optics claims attention in three interesting chapters. The statement on p. 626 that it is impossible to have a blue sea when the sky is overcast has been contradicted recently by Prof. Raman (NATURE, vol. 108, p. 367). The volume contains numerous solved problems in the text, and nearly 700 unsolved problems with answers in an appendix; the illustrations deserve a special word of commendation.

(3) Space is lacking for a full account of the high ideals which have inspired the author of this manual. Suffice it to say that the physics course in a modern (American) high school "should proceed toward an organisation of practical situations, activities, and phenomena, the value of which will be recognised and approved by teachers, students, parents, administrators of education, and others who are responsible for the work which boys and girls do in the high school"! Hence these ninety-five "projects" include the construction of "a model of a kitchen hot-water heater" (*sic*); studies of methods of heating or lighting a room; experiments on electroplating, saucepan conduction, and wireless; studies of the camera, the kerosene stove, the phonograph, and the sewing machine; and lastly a section headed "automobile work" dealing with carburettors, ignition systems, and the engine of a Ford car. Here is a course "organised according to the recognised function of education in a democratic society"! We cannot help feeling a certain amount of envy of the boys and girls in the modern high school.

(4) Messrs. Haler and Stuart have produced an introduction to physics based on experiments which can be carried out with simple apparatus. The scheme is intended to cover a two-years course for technical or trade schools, when two or three hours a week are devoted to the subject. Questions and numerical exercises are plentiful. It is scarcely logical to say that the absolute zero of temperature would be reached at $-273°$ C. when the only scale of temperature that has been described is that of the mercury thermometer.

(5) Mr. S. E. Brown has prepared a useful course on light to occupy two terms for pupils about fourteen years of age. There are plenty of experiments and illustrations, and the Barr and Stroud range-finder is

shown as a frontispiece. Teachers will welcome the large collection of examples and revision questions.

(6) Part 1 of the "Elements of Natural Science" includes mechanics, chemistry, heat, properties of matter, light, and sound. With part 2 the course is intended to cover the "general science" syllabuses of School Certificate and Army Entrance Examinations. The treatment of the subject-matter, together with the experiments in illustration, should prove successful in exciting and maintaining the interest of the student. H. S. A.

Parasitism and Symbiosis.

Le Parasitisme et la Symbiose. Par Prof. M. Caullery. (*Encyclopédie Scientifique: Bibliothèque de Biologie Générale.*) Pp. xiii + 400 + xii. (Paris: Gaston Doin, 1922.) 14 francs net.

FEW zoologists are so well qualified as Prof. Caullery, who is editing the series of works on general biology to which the volume under notice belongs, to survey the range of parasitism and symbiosis. He is the pupil and successor at the Sorbonne of Alfred Giard, and like him is distinguished by a remarkable versatility, having brilliantly investigated the life histories of parasites belonging to many phyla. In his laboratory, too, there was largely carried out the work of Guyenot on aseptic life, which is fundamental for future attempts to solve the problems of symbiosis.

There are good modern treatises on medical parasitology, but these naturally concern themselves with a much narrower field than that required by the student of general biology for whom this book is designed. Throughout, it is characterised by an admirable lucidity, and the vast amount of information it contains does not interfere with the well-balanced arrangement. Recent research which has a general bearing on parasitism is presented with great care, and the bibliography is complete and invaluable.

Commensalism, parasitism, and symbiosis are dealt with successively as related phenomena. The series of more or less modified parasites which exist in many animal groups offer perhaps the most striking illustrations which can be given of the reality of evolution. Prof. Caullery has treated the groups he knows best in detail from this standpoint. The adaptation of the parasitic isopods (especially Entoniscidæ) to their diverse hosts, the evolution of the Rhizocephala in the cirripedes, and the clear series of parasites in the gasteropods are given the attention they deserve. There might also have been included with advantage an account of the passage in the nematodes from forms with a perfect alimentary canal through the intermediate group of the Mermithidae to those complete parasites which absorb food only through the skin.

Passing over the very useful chapters on the various types of parasitic life-history, the migrations of "heteroxenous" forms, and the adaptations for reproduction in parasites, there follows an interesting discussion of specificity of parasites, especially in connection with human interference with the distribution of insects and the parasites they convey. We miss a reference to the very rigid specificity which is stated to exist in the Mallophaga, occurring on birds. Here the association of host and parasite apparently took place at an early stage in the evolution of both groups, and the well-marked systematic relationships of the different Mallophaga actually throw light on those of the bird genera on which they are found.

In the chapters on symbiosis reviews are given of the large number of cases recently described where unicellular symbiotes are found in different invertebrate groups, and then of the extraordinary extension of research on these lines by Pierantoni and Portier. The claim of the latter that every living cell contains symbiotic organisms was seriously considered and rejected by a committee of French biologists, but interest in research on symbiosis is still intense in France. F. A. POTTS.

Our Bookshelf.

Anleitung zur mineralogischen Bodenanalyse. Von Dr. Franz Steinriede. Zweite umgearbeitete und erweiterte Auflage. Pp. viii + 240. (Leipzig: W. Engelmann, 1921.) 60 marks.

THE original appearance of this book in 1889 marked the first serious attempt to apply petrological methods to the study of the minerals of the soil. During the thirty-two years that have since elapsed, petrological methods have undergone considerable development, while, on the other hand, our knowledge of the soil has similarly been enormously extended. The development of these two subjects, however, has proceeded mainly on quite separate lines, particularly in this country, where soil investigators have studied chiefly the chemical and biological aspects of soil fertility. That our present methods of examination of soil frequently fail us in accounting for observed differences in fertility is an indication of the need for new methods of attack, among which mineralogical analysis is undoubtedly of importance.

The appearance of the new edition of a book by a pioneer in the subject is thus welcome, especially as no similar book exists in this country. The author gives a succinct but adequate account of all the important aspects of the subject, including elutriation and flotation methods of separation, optical and other physical as well as chemical methods of examination. The data for the application of these methods are collected in a series of useful tables, together with a

detailed classified description of all minerals likely to be met with in soils. Finally, there is a systematic scheme for the detection and identification of the commoner of such minerals, and a bibliography of 136 references. This book and its subject merit the attention of all soil investigators. H. J. P.

Webbia: Raccoltà di scritti botanici. Edita da Prof. U. Martelli. Vol. Quinto, Parte 1ª. Pp. 355 + xiii plates + maps. (Firenze: Mariano Ricci, 1921.)

THE portrait of Odoardo Beccari which serves as frontispiece to the most recent instalment of "Webbia" reminds men of science that the death of that eminent traveller and botanist at the age of 77, on October 20, 1920, meant the loss of the chief authority on the natural history of Palms. Much of this part (pp. 5-198) is devoted to two important articles left complete when Beccari died. A "Review of the Old World *Corypheæ*" is an epitome of the monograph prepared by Beccari for the Annals of the Royal Botanic Garden, Calcutta, in continuation of those on "Asiatic Palms" published in 1908 and 1911. An account of "The Palms of New Caledonia" is of exceptional interest because the palms of this group of islands, though few in number, are all endemic species.

In "La Culla del Cocco" (pp. 201-294) Prof. E. Chiovenda reviews the evidence available as to the home of the coco-nut. Historical and ethnological considerations may be adduced in favour of either the Asiatic origin accepted by P. Miller (1752), R. Brown (1818), and A. R. Wallace (1853), or the American origin suggested by von Martius (1840), considered at first by A. de Candolle (1855) to be probable, and regarded by B. Seemann (1873) as assured. The taxonomic judgment of von Martius turned the scale in favour of America until Beccari (1877) showed that this judgment was contrary to morphological facts. These facts, indeed, contraindicate an American origin so that Beccari suggested instead a Polynesian one, while A. de Candolle (1883), writing now "with more information and greater experience," favoured a Malayan rather than an American origin. The renewed advocacy of an American origin by Dr. O. T. Cook (1900 and 1910) left Beccari (1916) indisposed to modify his earlier view. Careful consideration of all the evidence leads Chiovenda to agree with A. de Candolle's later belief.

"Webbia" since its inception has contained many important results of Beccari's botanical studies, and the editor, Prof. U. Martelli, fittingly concludes this part with a sympathetic "Memoir" (pp. 295-343) of that eminent man of science, to which is appended an invaluable bibliography (pp. 344-353) of Beccari's contributions to botanical literature.

The Journal of the Institute of Metals. No. 2, 1921. Vol. xxvi. Edited by G. Shaw Scott. Pp. x + 760 + pl. xxxiv. (London: Institute of Metals, 1921.) 31*s*. 6*d*. net.

THE growth in size of the half-yearly volumes of the Journal of the Institute of Metals is a striking indication of the increasing attention that is given in this country to the study of the non-ferrous metals. The lecture on the casting of metals by Prof. Turner, which occupies the first place in the present volume, directs attention to the comparative neglect of this important subject of casting by scientific workers, in spite of the high degree of practical skill that has been acquired by foundrymen, proceeding by a method of trial and error. The remaining papers deal with varied questions. A note on the characteristic defect which appears in some bars of extruded brass led to an interesting discussion at the meeting of the Institute, in the course of which laboratory experiments with wax models were cited in illustration of the mode of flow during extrusion. A second note on the casting of brass ingots shows the desirability of an exchange of information between ferrous and non-ferrous metallurgists, the device proposed having been long adopted in steel works. Other subjects treated are gun-metal, cold-working, scleroscope hardness, nickel-aluminium-copper alloys, etching methods, and the properties of rolled zinc. An important research by Dr. Hanson and Miss Gayler definitely connects the ageing of duralumin and similar alloys with the varying solubility of magnesium silicide in aluminium. The number of abstracts shows an increase on previous years. C. H. D.

(1) *A Short Course in Commercial Arithmetic and Accounts*. By A. Risdon Palmer. (Mathematical Series for Schools and Colleges.) Pp. x + 171 + xv. (London: G. Bell and Sons, Ltd.) 2*s*. 6*d*.

(2) *The Use of Graphs in Commerce and Industry*. By A. Risdon Palmer. (Handbooks of Commerce and Finance.) Pp. ix + 47. (London: G. Bell and Sons, Ltd.) 2*s*. net.

(1) MR. PALMER'S books on the application of elementary mathematics to commerce and industry are a welcome addition to the literature on the subject. His "Short Course" is a brief account of the most important arithmetical methods and processes required in commerce. Those who know Palmer and Stevenson's "Commercial Arithmetic and Accounts" will expect to find the new volume useful and interesting, and they will not be disappointed. There is a touch of real life about most of the chapters, especially that on "The Home Trade": one only misses the Public Receiver and the creditors' meeting. But are contracted methods really used in commercial life?

(2) Graphical representation is a useful and important process in industrial and commercial life; its vogue is increasing, and we have already had the case of a Cabinet Minister using a graph in the House of Commons to illustrate the activity of his department. While the methods are not exactly the same as those used in mathematics as such, the ideas are of course similar. One often wonders whether and how the ordinary newspaper reader understands the diagrams used in connection with price fluctuations or statistical reports. Mr. Palmer's little book will certainly be useful to all who have to deal with such pictorial information: it is indispensable to the business man and economist.

The book is the third of a series of handbooks of commerce and finance. Co-ordinates are explained and applied to the broken straight-line diagrams used by commercial and other journals, and the rectangle method and the sector method of representation used in books on geography, economics, and commerce are then discussed. There are a number of useful exercises.

S. BRODETSKY.

Ministry of Munitions and Department of Scientific and Industrial Research. Technical Records of Explosives Supply, 1915–1918. No. 8: *Solvent Recovery.* Pp. iv + 22. (London: H.M. Stationery Office, 1921.) 3*s.* net.

IN the manufacture of cordite, which is the propellant used in practically all arms in warfare, a mixture of nitrocellulose and nitroglycerin is incorporated with a "solvent," consisting of ether and alcohol, and the doughy mass is extruded through dies to form the cordite strands. These are dried on trays in closed recovery stoves, where the solvent is evaporated in a current of warm air until only a small amount of volatile matter remains, which is finally expelled in drying stoves. The solvent-laden air may be treated in absorbers for the recovery of the solvents. The present report deals with the use of sulphuric acid, water, and cresol as absorbents, the last being found most satisfactory. The air and absorbent were brought together in a Whessoe scrubber, such as is used in gas works, and the solvent then expelled by distillation. Calculations dealing with the operation of the plant are given.

A Manual of Selected Biochemical Methods as Applied to Urine, Blood, and Gastric Analysis. By Prof. F. P. Underhill. Pp. xiv + 232. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 17*s.* 6*d.* net.

A COLLECTED account of the various ingenious methods devised by American workers in the field of urine, blood, and gastric analysis will be found in this useful laboratory manual. Although doubtless the methods are adequate for the purposes described, it is somewhat surprising to find no reference to the Barcroft apparatus for determining oxygen capacity, nor to the almost indispensable comparator of Cole or Walpole for use with indicators in coloured solutions. Mett's tubes require more cautious criticism in quantitative work than is suggested by the author. These are perhaps minor blemishes, and, apart from them, the book can be highly recommended. It is to be feared, however, that the price will militate somewhat against a large sale in this country.

The Commercial Apple Industry of North America. By J. C. Folger and S. M. Thomson. (The Rural Science Series.) Pp. xxii + 466 + xxiv Plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1921.) 18*s.* net.

A FULL account of the growing of apples on a commercial scale in North America is given in this work, and much information that could be obtained only with difficulty elsewhere is embodied in the text. It would prove useful to any English grower or student of horticulture who wished to obtain information as to the way in which this important industry is carried on. The authors state in their introduction that they have visited practically every important apple-growing county in the United States, first in connection with an investigation into the cost of production, and later in connection with attempts to organise a system for estimating the apple crop of the United States.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On Immediate Solutions of Some Dynamical Problems.

As a branch of science advances and its principles become more familiar to the mind of the investigator many things which before appeared involved and mysterious become simple and clear, and it is possible to find proofs of theorems so obvious and brief as to merit the name *intuitive* in a very real sense, though not that in which the term is frequently applied. For to say that a theorem or principle is intuitively perceived is often tantamount to saying that it is not perceived at all. By an intuitive proof of a proposition I mean a proof which is natural and direct, and it may be almost instantaneous in that the restatement of some element of the proof transforms the whole so that the proposition is at once recognised to be true. But the proof must be complete and rigid to be valid, and completeness and rigidity are qualities which have come to be almost denied by calling a proof "intuitive."

I have amused myself from time to time with endeavouring to devise what I venture to think are properly called *immediate* proofs of dynamical propositions, and some of these, with historical notes here and there, may be of interest to readers of NATURE. Many of the ideas of attractions have become so familiar, not to students generally by any means, but to those who have pondered over the connection between the theory of gravitational attraction and the mathematical theory of electrostatics for example, that the subject has acquired a very special interest and fascination to the minds of such workers. Accordingly I give here some propositions in attractions.

It is undoubtedly the case that Newton delayed the publication of the discovery of universal gravitation until he had discovered a proof which satisfied him that a uniform spherical shell attracts an external particle, as it would if the whole mass of the shell were comprised in a particle situated at the centre. For if this proposition were established, the earth, which there was reason to believe was a nearly spherical body with a distribution of density approximately symmetrical about the centre, would attract external matter as if its whole mass were collected at the centre, and this therefore was the point from which distances were to be measured in the numerical comparison of gravitational forces; for example, the comparison of the two unital attractions of the earth, that on a particle at the surface and that on the moon.

The proposition given by Gauss that the surface integral of normal force taken over a closed surface drawn in the field is equal to $4\pi k$ times the whole quantity of the attracting matter which is contained within the closed surface, is capable of many applications. This proposition may be more precisely stated as follows: Let dS be an element of area of the surface and N be the component of the field intensity at right angles to the surface (taken positive when acting outwards). Then the integral

$$\int N dS,$$

taken over the closed surface, is called the surface

integral of normal force, more properly normal field intensity, and we have the equation

$$\int N dS = k 4\pi M,$$

where M is the whole quantity of matter inclosed by the surface, and k is the so-called gravitation constant, the force between two unit masses at unit distance. Take an example: Let the field be produced by a uniform spherical shell of radius a, and describe a sphere of radius R concentric with it. Consider a point P on this sphere; the field due to the shell must by symmetry have the same intensity at every such point as P, and the resultant intensity at P, which we call F, must be at right angles to the surface; thus we have for the surface integral of normal force $4\pi R^2 F$; the whole quantity of matter within the surface if ρ be the density of the shell, and da the shell's thickness, is $4\pi\rho a^2 da$; thus by the theorem we have

$$4\pi R^2 F = 4\pi k(4\pi\rho a^2 da),$$

that is,

$$F = k\frac{4\pi\rho a^2 da}{R^2},$$

that is, the field intensity is the same as if the whole mass of the shell were collected at the centre.

The only parts of this proof which are not altogether satisfying are those which depend on considerations of symmetry; but it will be tolerably clear that any distribution of matter must attract a distant particle after the manner stated, and no valid exception to them can be taken.

I shall return to this theorem of Gauss for a proof of another proposition. No doubt it can be applied, though Gauss its discoverer does not seem to have done so, to establish other propositions in attraction. We may prove the proposition with which we have just been dealing by the following discussion, which shows that the *potential* of a spherical shell at an external point is the same as if the whole mass were collected at the centre of the shell. The idea of potential was given in the treatment of attractive forces set forth in the "Mécanique Céleste" by Laplace: the name *potential* was given by Green, who made considerable use of Laplace's idea. It is remarked somewhere, though I cannot remember by whom, that it is perhaps easier to show that the attractive *force* of a spherical shell on an external particle is the same as if the whole mass were collected at the centre than to prove the same proposition for the potential. The proposition for the attraction is proved in Thomson and Tait's "Natural Philosophy" (a classic which, like the other great treatises, nobody now has time to read) by a reference to the point which is the inverse,[1] with respect to the sphere, of the external point. The proposition is proved also by direct integration in the "Natural Philosophy." In a paper on the historically famous problem of the attraction of an ellipsoid I have shown how the reference to the inverse point, in the case of the sphere, may be dispensed with, and the proposition as to the force established by what is practically an instantaneous proof. I shall here modify the method to give a proof of the theorem of the potential. Use of the inverse point for the potential was first made by my friend Mr. C. E. Wolff, and I have here adopted his idea of dealing with the attractions of two elements at once, the two intercepted by a small cone with its vertex at the point which I call the point corresponding to the external point P. This is the point A in the diagram (Fig. 1) in which the line CP intersects the shell so that A and P correspond to one another, as do two corresponding points on confocal ellipsoids. Of course the concentric spherical surfaces on which P and A lie are a particular case of confocal ellipsoids.

Let the circle EAE_1 (centre C) be a section of the shell by the paper, and P be the external point. Through P describe a sphere, radius f, concentric with the shell. Consider an element of area dS of the shell at E. If k be the gravitation constant, and σ the surface density of the shell, the potential at P due to the element is $k\sigma dS/r$. Produce all the radii to the boundary of dS to meet the concentric spherical surface, and give a new element of area dS' ($=dS \cdot f^2/a^2$) on the concentric surface at E′. From the points of the periphery of dS' draw lines all passing through A. These lines will include a cone of small solid angle ω with vertex at A, meeting the outer surface in the two elements dS' and dS_1' at E′ and E_1' respectively. The element dS_1 at E_1

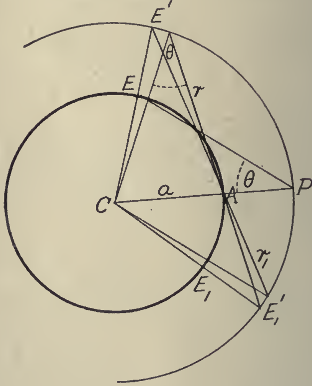

FIG. 1.

corresponds to an element dS_1' of the shell at E_1' at distance r_1 from A.

We have $dS' = \omega r^2/\cos\theta$, $dS_1' = \omega r_1^2/\cos\theta$.

The potential at P due to the two elements at E and E_1 is equal to the potential at A (the intersection of CP with the shell) due to the elements dS', dS_1' at E′, E_1', multiplied by the ratio a^2/f^2.

Thus if dV be the potential at P due to the pair of elements at E′, E_1' we have

$$dV = k\sigma\frac{a^2}{f^2}\omega\left(\frac{r^2}{r}+\frac{r'^2}{r'}\right)\frac{1}{\cos\theta} = k\sigma\frac{a^2}{f^2}2\omega f,$$

since $(r+r')/\cos\theta = 2f$. The potential at P produced by the whole shell is thus given by

$$V = k\sigma\frac{4\pi a^2}{f},$$

since the whole solid angle subtended at A by the external concentric sphere is 4π.

The proof of the theorem for the force is curiously different from that for the potential. Consider only a single element E in the diagram, and draw radii through all the points of the periphery of the element to meet the concentric surface through P; an element of this latter surface will be intercepted at E′. Let dS be the area of the element at E, and dS' that of the element at E′, and f the radius of the concentric sphere through P, and a as before the radius of the shell. We have then

$$dS = \frac{a^2}{f^2}dS'.$$

[1] The idea of using the inverse point in attractions of spheres seems to be due to Newton. See the "Principia," Book i., Proposition lxxxii., in which the attraction at an internal point of a spherical shell is deduced from that at an external point when the law of attraction is any function of the distance. In the text the law of the inverse square is alone considered.

Now from the diagram it will be seen that $\angle CE'A = \angle CPE = \theta$, say, and $EP = E'A = r$. The attraction due to E at P is equal to $k\sigma dS \cos\theta$, but this is clearly, if $r = EP$,

$$k\sigma \frac{a^2}{f^2} \frac{dS' \cos\theta}{r^2}.$$

Now the factor $dS' \cos\theta / r^2$ is clearly the solid angle subtended at A by the element dS'. The whole force exerted at P by the shell is thus, to a constant factor, equal to the solid angle subtended at A by the whole concentric surface of radius f, which is 4π. The attraction of the shell on a unit particle at P is thus $k4\pi\sigma a^2/f^2$, that is, it is the same as it would be if the whole mass were collected at the centre.

If the point P be internal to the shell the concentric surface with A falls within, and the total solid angle subtended by the shell at A is zero so that the attraction is zero.

This process extended to an ellipsoid and the confocal ellipsoid through an external point is made to give the force due to the shell at the point. The integration is made immediate by the use of a theorem of solid geometry which holds, as I pointed out, for confocal conicoids. The theorem may be stated here. Let A and P, E and E′ be pairs of corresponding points; then the distances AE′ and PE are equal, also if p and p' be the lengths of the perpendiculars from the centre on P and E′, θ the angle which PE makes with the perpendicular p, θ' the angle which E′A makes with the perpendicular p', then the theorem holds—

$$\frac{p}{\cos\theta} = \frac{p'}{\cos\theta'}.$$

This theorem shows the result of the integration over the ellipsoid to be, to a constant, equal to the solid angle subtended at an internal point by a closed surface in the manner just illustrated by the spherical shell. It is curious that this geometrical theorem which enables this result to be obtained is, as I have found, generally unknown to writers on geometry, and is not contained in any of the treatises which I have examined.

The next problem is one of which, I believe, the only simple solution given before 1900, was due to the late Prof. Tait, of Edinburgh. The problem was the determination of the pull between the two halves of a homogeneous sphere due to gravitational attraction. Prof. Tait's solution was a quasi-hydrostatic one, and I believe that he held the opinion that the only choice was between this and straightforward sextuple integration. There are, however, at least three other methods of attacking the problem, and one of these which occurred to me a long time ago I will indicate here. This has only been published so far as I know in a collection of exercises lithographed nearly twenty years ago by the late Dr. Walter Stewart, who was then my assistant, for the use of students in Glasgow. It makes use of the theorem of Gauss referred to above.

Consider the homogeneous sphere of radius a and let a closed surface be described consisting of a plane part dividing the sphere into two segments, and a spherical part fitting close to the smaller segment of the sphere. The surface integral of normal force over this surface will consist of two parts, I, the integral over the plane, and Σ the integral over the spherical portion. The mass M of the enclosed segment can easily be calculated and $4\pi k M$ is equal to $I + \Sigma$; of course Σ is also easily calculated, and thus I is obtained. If r be the radius of the plane section, z the distance of that section from the centre, ρ the density of the sphere, the mass of unit area of a disc of radius r and thickness dz is ρdz. Multiplying this by I, we see that the product $I\rho dz$ is the force due to the whole sphere on the disc of radius r and thickness dz, and if this be integrated from $z = a$ to $z = 0$ we obtain the attraction of the whole sphere on the hemisphere throughout which the integration has been carried; this attraction of the whole sphere on the hemisphere includes the attraction of this hemisphere on itself, which, of course, is zero. Thus the integration gives the attraction of one hemisphere by the other.

The mass M of the segment within the closed surface is easily seen to be

$$\frac{1}{3}\pi\rho(2a^3 - 3a^2 z + z^3);$$

the integral of normal force over the curved part of this segment is

$$\Sigma = 2\pi k a^2\left(1 - \frac{z}{a}\right)\frac{4}{3}\pi a\rho;$$

thus

$$I + \frac{8}{3}k\rho\pi^2 a^3\left(1 - \frac{z}{a}\right) = \frac{4}{3}k\rho\pi^2(2a^3 - 3a^2 z + z^3),$$

that is

$$I = \frac{4}{3}k\rho\pi^2 z(z^2 - a^2).$$

We have therefore for the product of I by the mass per unit area of the disc coinciding with the plane surface of the segment

$$I\rho dz = \frac{4}{3}k\rho^2\pi^2 z(z^2 - a^2)dz.$$

Integrating from $z = a$ to $z = 0$ we get for the pull P on one hemisphere exerted by the other,

$$P = \frac{1}{3}k\pi^2\rho^2 a^4,$$

or $3kM^2/16a^2$, where M is the mass of the sphere supposed of uniform density ρ.

A numerical estimate of P for the earth must be very rough, for the earth is not of uniform density, and there are other causes of inexactitude. But by the formula an estimate can be made in any units that may be preferred. In c.g.s. units k is $6{\cdot}7 \times 10^{-8}$. The force between the two hemispheres of a body of such great dimensions as the earth must be almost entirely due to gravitational attraction (for cohesion must be negligible in comparison), and this figure may be taken as giving an idea of its amount.

ANDREW GRAY.

The University, Glasgow.

The Conquest of Malaria.

THE obituary notice of Sir Patrick Manson, in NATURE of May 6, concludes with the hope that his memory may ever be kept alive as the Father of Tropical Medicine. As to this it is not difficult to forecast that the medical profession will fully concur. To the enthusiasm and inspiring teaching of Manson is due the existence of tropical medicine as a speciality, and the ever extending benefit tropical races receive at the hands of men trained on the lines indicated by him.

In the present day, the views of the medical profession are apt to change rapidly in accord with accumulated investigations and experiences of world-wide origin; opinions rigidly adhered to for fifty years may be rendered taboo by a single telegram received from some expert at a remote corner of the earth. If the new view stands the test of criticism the practical results are grasped; but few care to memorise how the change was effected. If this be so with the profession specially concerned with disease

prevention, it is not surprising to find that certain lay journals, in their biographical notes of Sir Patrick Manson, have given erroneous views of his connection with malaria prevention. Although, obviously, the well-informed writer of the obituary notice in your columns has no such intention, it seems to me that his quotation from NATURE (Vol. 61, 1900, p. 523) of matter by Sir Ronald Ross, unless considered side by side with other historical facts, is liable to accentuate the popular assumption that Ross, having been instructed by Manson as to what he would find in the mosquito, forthwith[1] performed the necessary hara-kiri—and the key to the etiology of malaria was found; and, therefore, to Manson and not to Ross is due the credit of the epoch-making discovery of malaria transmission. Yet Manson, with no less courtesy and frankness than displayed by Ross in elevating (in the matter quoted by your writer) what Manson himself termed a hypothesis to the rank of an induction, expressly disavowed any such claim.

In thus acting, Manson was fully aware of the great value to the British Empire and the world generally of the solution of the malaria problem which had been secured by Ross. In his paper read before the Royal Institute of Public Health Congress at Aberdeen, in 1900, he said: "I feel safe in asserting that malaria is far and away the most important of the many problems of tropical empire—that empire on which so much of our present and of our prospective national prosperity depends. The politician and the soldier may not think so. They are wrong. Such people habitually magnify their offices. . . . Our little wars and rebellions in their effects and importance are insignificant in comparison to the great natural phenomena, disease—to malaria for example." "My purpose . . . is to state . . . the . . . leading facts of the new knowledge which dawned only some twenty years ago with the discovery by Laveran of the cause and nature of malaria, and which culminated only two years ago when our countryman Ross showed how the infection is acquired, and in doing so clearly indicated in what way it is to be prevented."

To understand Manson's position it is necessary to indicate what was the actual "induction" he placed at the disposal of Ross. The following is found at pp. 16 and 17 of the first edition of "Tropical Diseases," by Manson: "I consider that the flagella—which as already stated are to be regarded as flagellated spores (*sic*)—are endowed . . . with locomotive powers, in order that they may be able to pass from the blood in the mosquito's stomach to the tissues of the insect. . . . The plasmodium, I hold, is an intracellular parasite both outside as well as inside the human body, and that when outside the human body it is parasitic in the mosquito. . . . The mosquito generally dies in the water beside the eggs she has deposited. When the eggs are hatched the young larvæ commonly devour the body of the parent and consequently her parasites. On the infected larvæ becoming mature insects the plasmodia they have swallowed continue, I conjecture, to develop. These insects, in their turn, infect their larvæ and so on. . . . *Man, I conjecture, may become infected by drinking water contaminated by the mosquito; or, and much more frequently, by inhaling the dust of the mud of dried-up mosquito pools; or in some similar way.*" (Italics not in original.)

Whilst, then, it is true Manson's induction of 1894 strengthened the hypotheses of Dr. A. F. A. King and Laveran as to mosquito agency, and this resulted in an inquiry by Ross as to possible extra-corporeal existence of the plasmodium, it is equally true that the work of Ross proved Manson's theories in essential details incorrect and misleading.

[1] Unaided by public funds, Ross devoted years of laborious experiments to the solution of the problem.

Holding in mind the Manson hypothesis, as stated by himself, if the quotation used by your writer be placed side by side with Manson's disavowal, it is not apparent there was any intention of Ross to say more than that the Manson hypothesis proved an incentive to action, and that in its absence it is probable research on the subject would have lapsed:

Ross.	Manson.
(Vol. 61, 1900, p. 523.)	("Tropical Diseases," ed. 1900, p. 21.)
"I have no hesitation in saying it was Manson's theory, and no other, which actually solved the problem; and, to be frank, I am equally certain that but for Manson's theory the problem would have remained unsolved at the present day."	"Thus by direct observation and analogy Ross distinctly, and first, proved that the extra-corporeal phase of the malaria parasite is passed in particular species of mosquitoes, and, by analogy, that the parasite *is transferred from man to man by the mosquito.*" (Italics not in the original.)

It need not be said that sanitary efforts based upon the mosquito contamination water theory of Manson could have secured no conquest of malaria.

W. G. KING.

Transcription of Russian Names.

THE system for transcribing Russian names advocated by Dr. Bohuslav Brauner in the issue of NATURE for April 29, namely, by the adoption of a few letters from the Bohemian alphabet, is open to serious objection.

In the first place, Bohemian is not the only Slavonic "State-tongue of an independent State." If Russian is to be transcribed into Latin characters as used by Slavs, the obvious model is Serbo-Croatian, which employs both Cyrillic and Latin characters, with regular rules for transcription. The Bohemian and Croatian alphabets are by no means identical; for instance, *ch*, which has in Bohemian the same sound as in German and Gaelic, would convey to a Croat some such sound as *tskh*; and he would not recognise some of the Bohemian letters bearing diacritical marks.

But if we are trying to abolish the Germanised and Gallicised forms of Russian names, why substitute another foreign form? These Slavonic letters with the diacritical marks are as unfamiliar to the ordinary Briton as the Cyrillic letters themselves,—*vide* Dr. Brauner's examples; and from this follows a practical difficulty in adopting his system in this country, namely, that very few printing presses and certainly no linotype machines have the necessary type, and the cost of introducing it would be prohibitive. Thus Dr. Brauner's "advantage of a great economy in printing" is outweighed by the disadvantage of impracticability in printing.

There is no reason why Russian personal names should not fall into line with Russian place-names, many of both being identical. And for Russian place-names the Permanent Committee on Geographical Names for British Official Use has adopted the system that has been in use for many years at the War Office, and also, except in one or two particulars, at the Admiralty. This is a system of transcription without the use of diacritical marks, which are undesirable in maps; the vowels have Italian values (e.g. *e*, *i*, *u*), and the consonants English values (e.g. *ch*, *sh*, *y*), the only exception being *j* which has the French value and is preferable to the un-English *zh* for this sound. If

it is desired to represent the Russian "soft sign," the apostrophe may be used. To take Dr. Brauner's examples, the Permanent Committee for Geographical Names would write Chicherin, Jemchujni, Mendeleev, Kon', Tatyana, Pushkin, Dyadya, Mechnikov.

Complete tables, not only of transcription from Russian but of the English values of other European and Near-Eastern alphabets, may be found in "Alphabets of Foreign Countries transcribed into English according to the R.G.S. II. System," recently published by and now obtainable at the Royal Geographical Society.

EDWARD GLEICHEN,
Chairman, Permanent Committee on Geographical Names.
Royal Geographical Society, Kensington Gore, London, S.W.7, May 7.

The Helmholtz Theory of Hearing.

DR. E. W. SCRIPTURE, in his letter on the above subject in NATURE of April 22, p. 518, has dealt with the case in which the note is continuously *changing*, and shows that when this is so every resonance organ of the ear must act at every instant for every vibration of the voice. Now suppose a pure fundamental note (*i.e.* one without harmonics) to be started and continued. At the start it would, on the principle of the apparatus designed by Dr. Hartridge, cause *all* the resonance organs of the ear to act, and we should hear a certain quantity of sound. Then gradually all, except one, of the resonance organs would cease to act, and we should hear only by means of the one which was synchronous with the pure note, and if this were so, presumably the quantity of sound would then appear to us much less than at the start. Has such an effect ever been recorded? If not, there would appear to be something wrong with the hypothesis.

A. S. E. ACKERMANN.
17 Victoria Street, Westminster, London, S.W.1, April 27.

PROF. SCRIPTURE has advanced in his letter in NATURE of April 22, p. 518, an argument which, if it were sound, would indeed necessitate the abandonment of the resonance theory. He must, therefore, excuse me if I point out what I consider to be the weak links in his chain of reasoning.

The first statement in his letter with which I find myself at variance is that according to the resonance theory only one resonator should respond to one tone. This is not only in disagreement with what Helmholtz wrote, but is also in disagreement with experiment. The resonance model referred to by Prof. Scripture, of which a photograph is reproduced in Fig. 1, showed that beside the intune resonator marked C being in vibration, there is also obvious movement in the one to the right-hand side as well. If there had been other pendulums of intermediate length mounted on either side of "C," there is no doubt that a number of these would also have been set into vibration, the actual number varying with the degree of damping applied to each. Helmholtz worked out the case of the ear resonators by means of calculations which appear to apply equally to all types of oscillating systems. He estimated that for tones about the middle of the musical scale, resonators having natural periods different from the incoming vibration by one semitone would be performing forced vibrations, the amplitudes of which would be approximately one-tenth that of the strictly intune resonator.

Now I have already stated (*Brit. Journ. Psych.*, April 1922, p. 370) the reasoning on which is based the estimate that some 600 resonators correspond to each octave in the musical scale. One semitone on either side of the intune resonator would, therefore, include about 100 resonators, and all these must be vibrating with one-tenth the amplitude (or more) of that of the intune one.

We see then how completely this estimate is at variance with Prof. Scripture's suggestion that according to the resonance theory only one resonator should be in vibration.

The second statement with which I cannot agree is that every vibration in a glide (since each vibration is different from the one which preceded) or every

FIG. 1.

spoken word (since the voice tone is continually changing) must therefore set every resonator into motion from the highest to the lowest, and I have never observed any behaviour on the part of my resonance model which would give any basis for such a supposition. I have attempted to calculate what would happen to a series of resonators which are set into vibration, not by a fixed tone, but by a tone changing in pitch. I find that, as in the case of a fixed tone, a group of resonators is set swinging, but that this group is larger than that set swinging by a pure tone, and I infer that the centre of this group moves up the scale with the same rate per second as does the incoming sound, but with a small time lag. For example, if the pitch of the tone is changing by as much as one octave per second the group of resonators appears to be only two or three times as large as that set swinging by a pure tone. Presumably then the tone will be quite recognisable, although it will not have the purity that a fixed tone possesses. This latter effect may possibly be correlated with the unpleasant character of a rapidly changing tone, *e.g.* the commencement of a steam syren blast. Whereas there does not appear to be any evidence at present by which the above estimate can be checked, yet I think that it must be at variance with the facts to state, as Professor Scripture has done, that when the pitch of the incoming vibrations vary, all resonators irrespective of length must be set equally into vibration.

I regret that it was my model which raised these doubts in Prof. Scripture's mind concerning the resonance theory. I should have made it quite clear to him that there was roughly a semitone difference of pitch between each pendulum and its neighbour. The model was not designed to demonstrate the better-known phenomena of resonance, but to elucidate the effect of interrupting temporarily a musical tone; for this purpose a few rather widely spaced pendulums sufficed. If the number of pendulums in the model had approximated more closely to the number apparently to be found in the ear, then Prof. Scripture would, I feel sure, never have criticised the resonance theory as he has done.

H. HARTRIDGE.
King's College, Cambridge, April 26.

Directive Radio-telegraphy and Navigation.

In foggy weather, sound-signalling stations have proved useful as an aid to navigation. The sounds heard, however, cannot be trusted to give accurate indications either of the distance or direction of the station. Their range also is very limited. It is not surprising, therefore, that many suggestions have been made for utilising the electric waves used in radio-telegraphy to enable a navigator to find his bearings. The propagation of electric waves is unaffected by fog and, unlike sound or light waves, can be transmitted to any distance. Moreover, the apparatus required for radio-signalling is very cheap, requires little skilled attention, and can easily be installed in lighthouses and lightships. Until two or three years ago the radiophares—or radio-beacons as they are called in America—were purely stations for giving ships their positions. In order to find its bearings a ship must send a message to two or more stations, and its direction is located by direction-finding coils. The stations then communicate with one another and so, by the help of triangulation, find the position of the ship, which is communicated to it by radio-telegraphy. In practice the whole operation takes about five minutes. The most extensive chain of direction-finding stations is that controlled by the United States Navy. There are at least thirty stations on the Atlantic seaboard and several on the Pacific coast. France has about ten radiophares and this country has six. A drawback to the method is that valuable time may be lost in getting into communication with the radiophares and in getting the information back to the ship.

A new and very promising method has been recently developed by the Bureau of Standards at Washington in co-operation with the Bureau of Lighthouses. In this method lighthouses and lightships the locations of which are accurately shown on sailing charts are equipped with radio fog-signalling apparatus. A direction-finder operated by the navigating officer is installed in the ship. It is then easy to find the directions of the various radiophares within his range and thus work out his position on the chart. The results obtained by this method have been very successful, and it seems to be much preferable to the ordinary method of using the direction-finder at the fixed stations. It seems probable that every important lighthouse in America will soon become a radio fog-signalling station. The Bureau of Standards suggests that radiophares should be divided into three classes. The first, or long-range class, has a radius of action of 300 miles. The second, or short-range class, can signal to 30 miles; and the third class comprises the lightship stations which can signal to 10 miles.

The method has been made possible by the perfecting of a new radio direction-finder. The principle on which it acts is that the signals received by a flat coil have their maximum intensity when the direction from which they come is in the plane of the coil. When certain precautions are also taken in arranging the apparatus, the signals are of practically zero intensity when the plane of the coil is perpendicular to the direction from which they come. As Fig. 1 shows, it is designed to be installed over the ship's binnacle carrying the magnetic compass. The radio-bearings are read directly on the magnetic compass card. An additional scale, marked with the corrections obtained when calibrating the instrument, is attached to the top of the binnacle so that the true reading can be obtained at once. When taking a bearing the only operation necessary is to rotate the direction-finding coil until the sound is a minimum. The ordinary type of direction-finder for use on shipboard consists of a coil of ten turns of insulated copper wire wound on a wooden frame four foot square, which is mounted so that it can be rotated about a vertical axis. Suitable receiving apparatus is used in connection with this coil, namely, a variable air condenser for tuning purposes, a six-tube amplifier having three stages of radio-frequency amplification, a detector, two stages of audio-frequency amplification, batteries, and suitable telephone receivers.

Fig. 1.—Magnetic compass with direction-finder attachment for reading the radio-bearing directly on the magnetic compass.

The Bureau of Standards have issued a pamphlet by F. A. Kolster and F. W. Dunmore giving a full description of the direction-finder, pointing out some of the difficulties that had to be overcome in developing it, and giving many experimental results.

The Cause and Character of Earthquakes.[1]

By R. D. Oldham, F.R.S.

The study of earthquakes, using that word in the restricted, and original, sense of the disturbance of the ground which is sensible to human feelings, which causes alarm and destruction, and is properly that seism of the ancient Greeks, from which our modern term seismology is derived, has always been recognised as one of the departments of geology. This limitation is necessary, for, of late years, seismology has been extended to the study of a phenomenon of different character, the long-distance records of dis-

[1] Abridged from the presidential address delivered before the Geological Society of London on February 17.

turbances, only to be detected by very sensitive instruments of special construction; in some cases these are clearly connected with great earthquakes—as the word is here used—and by inference have been presumed to be so in all cases, even when there is no independent evidence of the earthquake proper. The records, regarded as records of the progressive enfeeblement of the larger disturbance of the true earthquake, would represent the cryptoseism, or unfelt earthquake, and be described correctly in the observatory records as earthquakes. That they are correctly so described is indisputable, if the word is taken in its literal interpretation as a quaking, however feeble, of the earth; but if the implication is added that they have the same origin as the greater disturbance, the correctness of the description becomes doubtful.

Some dozen years ago the results of a study of the records of the Californian earthquake of 1906 led me to point out that, while the immediate origin of the earthquake proper may be traced to occurrences which take place in the outermost parts of the earth's crust, these are but the secondary result of a deep-seated origin, or bathyseism, which gives rise, at the same time, to the disturbance which is recorded at long distances by suitable instruments. Later work and research has more and more confirmed both the correctness of this interpretation and the conclusion that the proximate cause, of great and destructive earthquakes, is distinct from that of the long-distance records, though the two origins are connected with each other as effect and cause.

In the present state of our ignorance of the nature of the bathyseism, it is difficult to give a clear and precise definition of the mode of connection between it and the earthquake proper; the subject is an interesting one, and a review of the evidence, together with the deductions which can be drawn from it, would fill the time available, but it is not my intention to do more than to attempt, by analogy, to illustrate and explain the nature of the connection of the bathyseism with its two independent results.

Not many years have passed since, in the south-eastern corner of England, we heard what were known as the guns of Flanders; and the description was correct. The sound—it was more a sensation than a sound—which was heard in Kent and Sussex was undoubtedly produced by the report of great guns, by the explosion, that is, of the charge in the gun itself; but had the explosion done no more than give rise to the sound waves which travelled far in every direction it would have little troubled the enemy. Simultaneously, however, with the production of the report, and by the same explosion, a projectile was sent flying through the air which exploded after a trajectory of some miles, causing the damage which was the purpose of its despatch. The effect of this second explosion was severe but local, and at a short distance away neither sound nor shock was sensible.

Here we have a very complete analogy; the explosion of the gun represents the bathyseism; the report and sound waves travelling afar, correspond to the disturbance which, propagated through the substance of the earth, gives rise to the long-distance records: the explosion of the shell to those dislocations in the outer crust which produce the destructive earthquake; and the trajectory to the connection, of which the character is as yet unknown, between the bathyseism and the surface shock.

If this interpretation be accepted, it becomes evident that the distant records represent something which is distinct from the earthquake, as originally understood, and that the study of records, with the deductions drawn from that study, have little or no bearing on the problems of geology, as we usually limit the scope of that science. It is otherwise with the earthquake proper; originating in, and affecting, the outermost crust of the earth, it has long, and rightly, been regarded as one of the departments of geology, both as regards cause and character, and it is with this aspect of the subject alone that I shall deal.

The character of earthquakes is known to an extent sufficient for my purpose; they are elastic waves, transmitted through the substance of the earth, not, as was once supposed, merely waves of elastic compression, but of most complicated character, and, in all but a small minority of cases, nothing but this vibratory movement, the orchesis, can be recognised. Occasionally, however, and only in the case of some earthquakes of destructive violence, there is also a bodily and permanent displacement of the solid ground, and this mass, or molar, movement has been distinguished as the mochleusis of the earthquake, as distinct from the elastic displacement, accompanied by return to the original position, which constitutes the orchesis. Now the elastic waves can only be initiated by some sudden impulse or disturbance, such as might be produced by the fracture of rock, and as, in those earthquakes where mochleusis can be recognised, there is usually evidence of sudden movement along some pre-existent fault-plane, or of rending and fissuring of the solid rock, faulting or fracturing has come to be regarded as the cause from which the vibratory disturbance, propagated through the unfractured rock, originates.

This conclusion is supported by the fact that the proximate origin of the shock can almost always be placed at a moderate depth from the surface. It is, unfortunately, impossible to give any precise figures, for none of the methods which have been suggested for determining the depth of the origin can be trusted, some because they depend on assumptions which the progress of knowledge has shown to be erroneous, others because they demand data which cannot be supplied with the requisite precision, if at all; but there is another way in which some idea of the depth of origin may be reached, based on the fact that there is usually a well-defined area of maximum intensity of shock, surrounded by regions of diminishing intensity, as the distance from the central area increases. Since the violence of the disturbance will decrease with the increase of distance from the origin, it follows that, the nearer the origin lies to the surface the more closely does the variation of surface distance from the epicentre approximate to the variation in actual distance from the origin; hence it is evident that the rate of variation of intensity of the disturbance will give some notion of the depth of the origin. In this way, quite apart from any numerical estimates which have been made, it becomes clear that, excluding a small minority of earthquakes which will be referred to later, the origin lies

at a very moderate depth below the surface, probably seldom over ten miles, and usually less, that is to say, within the limits of the solid outer crust of the earth; and in this region it is difficult to conceive of any cause, sufficient to originate the elastic wave-motion of the earthquake, other than the sudden fracture of the solid rock, where strain has outgrown the power of resistance.

Apart from this general reasoning from observation, there are cases on record where considerable displacements of the ground have been measured by the comparison of careful and accurate surveys made before and after the earthquake. In three of these—the Cutch earthquake of 1819, the Sumatran of 1892, and the Californian of 1906—the largest movements took place close to the line of fracture, and in opposite directions on opposite sides of it, the displacements decreasing on either side till a region was reached in which no change, from the condition before the earthquake, could be recognised. As this is precisely what would take place if a solid body, capable of elastic deformation, was strained until fracture took place, the conclusion is justifiable that such was in fact the origin of the dislocation and displacements.

So far the conclusions, which may be drawn from observation, as they have been briefly outlined, belong rather to the domain of physics than of geology, but when we go on to consider the cause to which the strain is to be attributed, and more especially the rate of growth, we are brought into contact with problems and deductions which are intimately connected with geology proper, and to which I propose to confine attention in the remainder of this address. As regards cause: this is usually attributed to what are known as the tectonic processes, a term which may approximately be described as the processes by which the folding and faulting of rocks were produced, and, in accordance with this attribution, the class of earthquakes with which we are concerned is referred to as tectonic. The rate of growth of strain has almost invariably been accepted as very slow, yet when the subject is looked into, it will be found that there is really no evidence to support the acceptance; in part it must be attributed to the general belief that all geological action is necessarily slow, and in part to the conclusion that the Earth is a solid inert and highly heated body, cooling slowly by radiation, with the subsidiary deduction that all deformation of the outer crust must be referred to contraction, consequent on that slow cooling. The latter of these reasons is now abandoned by those who forced it on us, and the former, though true in general, must not be treated as an unchangeable law, for there are many cases where a process, slow on the average, and as a rule, is occasionally subject to temporary acceleration of rate. The evidence, too, which has been regarded as confirmatory of the slow growth of strain, is, in truth, more properly described as an interpretation of observed facts in accordance with an hypothesis.

In the report on the Californian earthquake of 1906, for instance, the displacements caused by that earthquake and an earlier one in 1868 are explained by a slow growth of strain, extending over a century or so, partly relieved by fracture in 1868, and again in 1906. The argument is conclusive in so far as it shows that the effects are consistent with the hypothesis, but it was not noticed that they would be equally consistent with a condition of quiescence throughout the whole period, with the exception of two short intervals immediately preceding the two shocks, respectively. The same may be said of all the supposed evidence in favour of a slow growth of strain; it is true that in those earthquakes which have been investigated in detail, and in which the observations allow of any definite conclusion, the indications point to the conclusion that the proximate cause is fracture resulting from excessive strain, but there is in no case any evidence of the rate at which that strain accumulated; nor is it possible that any such evidence could be found. The after-effects may satisfactorily establish the conclusion as to the cause, but they can give no indication of the time occupied in preparation; the earthquake comes and passes, it leaves certain records behind it, but these records would be the same whether the preparatory growth of strain was secular or instantaneous in duration.

Yet the problem is not insoluble, for there is another line of attack, which has only become practicable within the last few years. If we regard the growth of strain as continuous, there will be a certain increment which will lead to fracture, earthquake, and partial relief; then with a further increment the process will be repeated, and so we reach the concept of a mean-strain interval for each shock, which may be regarded as constant, on the average, for any given region, provided that the average is taken over a sufficiently long period. Any variation in the rate of growth of strain must be accompanied by a corresponding variation in the frequency of earthquakes. We have, then, four quantities so related to each other that if three of them are known the fourth can be determined. Of these four, two, namely the mean frequency and the variation from that mean in any chosen period, can be obtained from observation, and if the variation from the mean rate of growth of strain is also known, for the selected portion of the whole period, that mean rate which is the object of search can be obtained by a simple rule of three sum. So that if there were any external cause which, acting periodically and alternately in increase and decrease of the rate of growth of strain, and if it were possible to disentangle the variations due to this from those due to other causes, we would have a means of framing a numerical estimate of the general rate of growth of strain.

One such cause of periodic variation is to be found in the tide-producing stresses set up by the sun and the moon. It is true that many attempts have been made at different times to detect some connection between the frequency of earthquakes and the position of the moon, and that no such connection has yet been established, but these attempts have all been based on very imperfect records. In time it may, perhaps, be possible to apply to an earthquake record the method of harmonic analysis, which has proved so fertile in the case of the ocean tides, but the day is long distant when a record of sufficient completeness will be available. Meanwhile there are some simpler relations, of

which a discussion is feasible, and the most promising of these seems to depend on the fact that the downward pressure is greatest at the time when the attracting body is on the horizon, and least when it is on the meridian. If, then, we divide an earthquake record into two groups, one containing all shocks which occur within six hours before a meridian passage, and the other all that happened within six hours after, one of the two groups will cover a period during which the downward pressure is, on the average, increasing, while the other will cover the period during which it is decreasing. As the amount of the change so introduced is known, with sufficient accuracy for the present purpose, and as it should, on the hypothesis being used, influence the frequency of earthquakes, it follows that we have here a method, which should enable us to make an estimate of the rate of growth of the strain, to which fracture is due.

Although simple in principle, the method is difficult in application. To begin with, a record is required of sufficient extent and continuity to give a trustworthy average, not merely of the general frequency, but also of the frequency in each of the two sections into which it is divided, and this in practice means that the record must contain at least two thousand shocks and ought to contain double that number or more. Then it must be reasonably accurate as to times and complete as to occurrences, or at least must be fairly uniform in its incompleteness over the whole period investigated. There are not many records which fulfil these primary requirements, but there is another even more important. In all records there is a noticeable variation in frequency at different times of the day, moreover, the nature of this diurnal variation has been found to vary in different regions, but appears to be constant and characteristic, in each region, over the period of record. The cause of this periodicity may reasonably be attributed to some effect, meteorological or other, connected with the daily course of the sun, but its nature, no less than its variability, shows that it can only be attributed in part, if at all, to gravitational attraction. It is only, therefore, by a conversion of the record from solar to lunar times that the influences of these other effects can be eliminated, and the gravitational attraction of the moon be detected and estimated, and, for the satisfactory application of this method, it is necessary that the record should cover a complete lunar cycle, or a period of nineteen years. There are only two records extant and available which fulfil this requirement, and of these the Italian is not only the most complete and accurate, but is the only one to which the conversion into lunar times has been applied.

From the summary of the figures obtained, published in our Quarterly Journal, it appears that in the six hours preceding and following a meridian passage the mean departure, from the general average for six lunar hours, is almost exactly 1 per cent. of the mean.

Passing over details of calculation, the average rate of growth of strain is found to be such that the breaking point would be reached in about two months from the start, with a wide variation on either side. Some other relations between the frequency of earthquakes and the diurnal variation of the tidal stresses might be, and have been, investigated; all give fairly confirmatory results, the longest period indicated as required for reaching the breaking strain being just about a year.

It must not be supposed that value can be attached to the precise figures. As is invariably the case, in all calculations regarding physics of the earth, many considerations are involved of a very uncertain nature, but the reasoning does show that the increase of strain must have taken place at such rate that the breaking point was reached in a period measurable at most by months, and shows that the period could not have been of such length as to be measurable by years or decades, for, had this been the case, the disparity dealt with would have been much greater than that actually found.

(*To be continued.*)

Obituary.

PROF. G. S. BOULGER.

BY the death of Prof. G. S. Boulger on May 4, botanical science has lost an accurate and advanced observer who did much to popularise the study of his favourite science, and left his impress on several generations of devoted students. He was an active botanist to the end. On April 26 he attended, as chairman, the meeting of the Botanical Section of the South-eastern Union of Scientific Societies, and he himself was struck by the difficulty in breathing which he experienced in mounting a number of stairs to the meeting-room. Almost his last words on his death-bed had reference to the preparation of the report to be presented to the Congress of the Union at Southampton in June. He died literally in harness.

Prof. Boulger was born in 1853, and was educated at Wellington and Epsom Colleges; at an early age he became Professor of Natural History at Cirencester College, holding the chair for thirty years. Among other appointments which he held were those of professor of geology and botany at the City of London College, and in recent years he was a guide at the Imperial Institute. But his students were a wider public than institutions afforded. He was in considerable request as a public lecturer, and frequently visited, as such, various local natural history societies. He was closely connected with the Selborne Society, of which he was a vice-president, and the magazine of which, *Nature Notes*, he edited for some years. In recent years he was much interested in what has come to be known as Regional Survey, and in this connection did good work for the Gilbert White Fellowship, an up-to-date survey of Selborne being now in progress.

As an author Prof. Boulger had an attractive style. For some time he edited the Proceedings of the Geologists' Association. His knowledge of geology enabled him to throw considerable light on the origin of the British flora. His "Biographical Index of British and Irish Botanists," with Mr. J. Britten, is a valuable book of reference. His "Familiar Trees,"

and "The Country Month by Month," with J. Owen (Mrs. Owen Visger), brought him into touch with a wide public, and his edition of Johns' "Flowers of the Field" has proved invaluable to thousands of amateur botanists. Other works of his were "The Uses of Plants," "Elementary Geology," and "Plant Geography." He was for a long time the Kew Gardens correspondent of the *Times*. He always faced troubles cheerfully, and, constantly active, it is to be feared that overwork may have had much to do with his regretted death. His loss will be greatly felt by workers in many fields.

By the death of Dr. C. W. Waidner on March 10, the Bureau of Standards lost the third member of its original staff within the last year. Dr. Waidner was born in Baltimore in 1873, graduated at the Johns Hopkins University in 1896 and remained there, engaged first in research and afterwards in teaching, till he was appointed to the staff of the Bureau on its foundation in 1901. In a short time he became head of the Heat and Thermometry department, and organised the testing of thermometers of all kinds from clinical instruments to optical pyrometers. In conjunction with various members of his staff—most often with Dr. G. K. Burgess—he published a number of papers which did much to increase the precision with which temperatures could be determined. Of these papers it is only necessary to mention those on a comparator for thermometers, on radiation pyrometry, on the high temperature scale, on standards of light, on the platinum thermometer and the melting-point of platinum, and on the possibility of detecting the presence of icebergs by the temperature of the ocean, to show the nature and extent of his work. In recent years his interests have centred mainly in the applications of physics to problems of refrigeration and to the production of fire-resisting structures. In these fields his loss will be severely felt.

In the *Chemiker Zeitung* of April 15 the death is announced, at the age of sixty years, of Dr. F. Voigtländer, emeritus professor of chemistry at the University of Hamburg.

The U.S. Public Health Service has lost, by his death at the age of forty-eight, the skilled assistance of its assistant epidemiologist, Dr. David G. Willets. He had spent several years at Manila, at first in the biological laboratory of the Bureau of Science and afterward on the staff of the University of the Philippines. He had written many bulletins and monographs on pellagra, intestinal parasites, and other tropical problems.

Current Topics and Events.

The one hundred and fiftieth anniversary of the foundation of the Royal Academy of Belgium will be celebrated in Brussels on May 23-24. More than ninety delegates, representing forty-five academies in eighteen different countries, in addition to foreign associates of the Belgian Academy, are expected to attend the function. France is sending a number of representatives; the Institute of France alone will have thirty-six delegates. We learn from the Secretary of the Academy that the learned societies of Great Britain will be represented as follows: Royal Society, Sir William Leishman and Prof. H. Lamb (also representing the Cambridge Philosophical Society); Royal Society of Edinburgh, Sir George Berry; Royal Academy, Sir George Frampton, Sir Reginald Blomfield, and Mr. H. Hughes-Stanton; Royal Institute of British Architects, Sir John Burnet, Mr. J. Simpson, and Mr. P. Waterhouse; Royal Geographical Society, Sir Frederick Sykes; Royal Historical Society, Mr. G. M. T. Omond; British Academy, Sir Frederic Kenyon and Mr. H. Stuart-Jones; Chemical Society, Sir William Pope; Zoological Society, Dr. G. A. Boulenger and Dr. P. Chalmers Mitchell; Asiatic Society of Bengal, Sir Thomas H. Holland and Dr. Pascoe. The following British Associates of the Belgian Academy will be present: Sir Frank Dyson, Sir T. Erskine Holland, Sir Frederick Pollock, Sir Thomas Jackson, Sir John Lavery, and Mr. J. Pennell. The learned societies of Australia and New Zealand and the Royal Irish Academy have sent congratulatory addresses.

The *Times* of May 9 records the striking of petroleum (on the previous day) in a well put down at Darcy, near Dalkeith, on the property of Lord Lothian. The well was originally one of the two selected sites in Scotland in accordance with the Government's drilling programme of 1918, the other, at West Calder, having since been abandoned after being drilled to a depth of 3923 feet. The Darcy well is producing from a sandstone at a depth of 1810 feet, and the oil, though inferior both in quality and quantity to that obtained at Hardstoft, is of paraffin base, somewhat viscous, and carries much gas. Previous to the flow, 8-inch casing had been set in the hole and the oil accumulated afterwards for several hundred feet within it. The bringing in of this well is an event of scientific rather than economic importance, as the initial yield is, commercially speaking, insignificant, while the prospects of the area as a whole are geologically unfavourable to the development of a large oilfield. Hardstoft, the only other producing well in this country, makes an average of 20 barrels per week; the Darcy well is said to yield considerably less *pro rata*. The same number of the *Times* contains the report of a serious announcement concerning the world's oil supplies, made by Prof. Arrhenius, at the close of a course of lectures given at the Sorbonne. Prof. Arrhenius stated that at the present rate of consumption the existing oilfields in the world would, in his opinion, be exhausted within 15 years, an opinion shared by many experts both in this country and in America.

The natural corollary to such a prediction is the recognition of the need for conservation of the world's petroleum resources, especially those of the United States. The development of other sources of fuel, more particularly oil shale, and the ultimate harnessing of forms of energy such as Prof. Arrhenius suggested (plants, watercourses, winds, and the heat of the sun), are matters demanding the assiduous attention of scientific investigators.

THE Governors of the Imperial College of Science and Technology have appointed Sir Thomas H. Holland to be Rector of the College in succession to Sir Alfred Keogh, who is retiring at the close of the Summer term. Sir Thomas Holland is best known by his work in India. Among the many important positions filled by him there were the directorship of the Geological Survey, the presidency of the Industrial Commission and of the Board of Munitions, and more recently membership of the Governor-General's Council. Apart from his important administrative experience his scientific interests centre round geology and oil. He has been a member of many commissions and committees concerned with oil, and for ten years was professor of geology and mineralogy at the University of Manchester. His appointment is also interesting in that he is an old student of the Royal College of Science, having been awarded his associateship in geology of that College, which is now an integral part of the Imperial College, in 1888; and also in that in 1910 he was president of the Old Students' Association of the College, and later a member of the governing body representing the Indian Empire.

THE annual visitation of the Royal Observatory, Greenwich, will be held on Saturday, June 3.

SIR RICHARD GREGORY has been elected president of the Decimal Association in succession to the late Lord Belhaven and Stenton.

AT the meeting of the Royal Society on June 1, the Croonian lecture will be delivered by Prof. T. H. Morgan on "The Mechanism of Heredity."

THE annual Conversazione of the Institution of Electrical Engineers will be held on Thursday, June 29, at 8.30 P.M. at the Natural History Museum, South Kensington, S.W.

THE annual general meeting of the People's League of Health will be held at the Mansion House on Thursday, May 25, at 3.30 P.M. The Lord Mayor will preside, and among the speakers will be Sir Bruce Bruce-Porter, Dr. Farquhar Buzzard, Sir Gilbert Garnsey, Miss Olga Nethersole, and Dr. Saleeby.

THE Linnean Society has recently elected the following as Foreign Members: Lucien Cuénot, professor of zootechnic, entomology, and parasitology in the University of Nancy; Gustave Gilson, director of the Royal Museum of Natural History, Brussels; Jakob Wilhelm Ebbe Gustaf Leche, professor of zoology in the High School, Stockholm; and Dr. Benjamin Lincoln Robinson, Asa Gray professor of systematic botany, and curator of the Gray Herbarium, Harvard University, Cambridge, Massachusetts.

DR. W. BATESON, director of the John Innes Horticultural Institution, Merton, Surrey, has been elected a trustee of the British Museum, to fill the vacancy caused by the death of Lord Harcourt. Other Fellows of the Royal Society who are among the elected trustees of the Museum are Lord Rothschild, Sir Henry Howorth, Sir Archibald Geikie, and Sir J. J. Thomson.

THE *Meteorological Magazine* for April has a note on wireless apparatus for Tristan da Cunha. The Rev. H. M. Rogers, who sailed from South Africa in March to take up the chaplaincy of Tristan da Cunha, has taken with him apparatus with a range of more than 1000 miles. The instruments were presented by the people of Cape Town, who have always shown a keen interest in the loneliness of the island. A meteorological equipment was also presented by the Government, so that Mr. Rogers may send reports of weather conditions in the islets by wireless telegraphy to South Africa and to passing ships; it is thought that the messages will greatly aid weather forecasting.

THE sixtieth birthday of Prof. David Hilbert of Göttingen has been celebrated by the publication of a special number of *Die Naturwissenschaften* (January 27). Opening with a portrait of Prof. Hilbert, it contains an admirable account of his life work by Herr O. Blumenthal, of Aachen. There follow five more specialised appreciations, by different writers, of his work as an algebraist, a geometer, an analyst, a physicist, and a philosopher. Finally, appears a list of Prof. Hilbert's memoirs, eighty-three in all, accompanied in many cases by short abstracts of the results contained in them. Among the ranks of living mathematicians no name is more honoured than Prof. Hilbert's, and this tribute to his fame is well worthy of the occasion it celebrates.

IN July this year, Mr. E. Grey, Field Superintendent of the Rothamsted Experimental Station, will complete fifty years of continuous work at Rothamsted. To mark the widespread appreciation of his valuable services during this long period, it has been decided to raise a fund for a testimonial which shall take the form most agreeable to Mr. Grey himself. There are probably many readers of NATURE who may wish to associate themselves with this testimonial. The director and staff of the station therefore invite subscriptions, which should be sent as soon as possible to the Secretary, Rothamsted Experimental Station, Harpenden, Herts. Mr. Grey's book, entitled "Reminiscences, Tales, and Anecdotes of the Rothamsted Experimental Station Laboratories, Staff, and Fields, 1872–1922," is now in the press and copies can be obtained from the Secretary, Rothamsted Experimental Station, Harpenden, or from Mr. E. Grey, Laboratory Cottages, Harpenden. Price 5*s*. 9*d*. post free. All profits will go to Mr. Grey.

FROM the Report of the Board of the Institute of Physics for the year 1921 we learn that the Institute

now has 400 members, 250 of whom are fellows. The income from subscriptions was a little over 500*l.* and the office salaries 500*l.* During the year the Board formulated a scheme for the publication of a *Journal of Scientific Instruments*, and the Institute has received a grant of 250*l.* from the Department of Scientific and Industrial Research to enable it to produce the first number. The Institute has provided 50*l.* for the expenses of distribution of the 10,000 copies which have been printed, and in a short time the number will be in the hands of those likely to be interested in such a Journal. The price will be 30*s.* per annum if sufficient support is provided by instrument makers, research associations, scientific societies, and the public to justify the regular issue of such a periodical.

The Board of Education has issued a memorandum on the effect of the Summer Time Act on the health of school children. All Local Education Authorities in England and Wales were circularised in May 1921, and only 16 authorities, representing about 127,000 children, failed to reply. Of the 299 authorities from which replies were obtained, 183 authorities, representing 3,227,842 children, are definitely in favour of the Act; 89 authorities, representing 1,600,429 children, consider the Act detrimental, while 27 authorities, representing 232,402 children, have not formed a definite opinion. It should be added that nearly all authorities who hold that the Act is prejudicial to children, state that this is due, not to any defect inherent in the Act itself, but to the fact that parents do not use it rightly. If parental control were properly exercised nearly every authority in the country would approve the Act. The actual (though not the necessary) result of the Act appears to be that large numbers of children lose a valuable hour of sleep, because they go to bed at dusk as before, but have to get up an hour earlier, as the working part of the family rises by the clock. The Board is therefore issuing a circular to the parents of school children, pointing out how important adequate sleep is for the growing child, stating the amount of sleep necessary at the different ages, and supporting the arguments by some common-sense appeals to the parents.

It is announced that the British Association for the Advancement of Science will publish, early next month, "The British Association: A Retrospect, 1831–1921," by the Secretary of the Association, Mr. O. J. R. Howarth, which will present a summary review of the activities of the association in every department of science since its foundation. The production of this volume has been rendered possible through the generosity of Sir Charles Parsons, ex-president, at whose suggestion it was undertaken.

Our Astronomical Column.

A New Variable in Cygnus.—The star B.D. +34° 4217 (position for 1900: R.A. 20h. 54m. 12s. Decl. +34° 47′·4) has been discovered by Mr. Stanley Williams to be a short-period variable (*Monthly Notices*, R.A.S., vol. 82, p. 300). He commenced visual observations on this star with a 6½-in. reflector in October last, and has deduced a light curve which at first appeared to be of an Algol type, but later was found closely to resemble that of β Lyrae. The period is about 15h. 9m. and the range of magnitude 10·42 to 9·93, the magnitude at secondary minimum being 10·15.

The Spectrum of the Corona in 1918.—The expedition sent from the Lowell Observatory to observe the eclipse of June 8, 1918, was stationed near Syracuse, Kansas, and obtained some interesting results in spite of rather unfavourable weather. The equipment consisted of two single-prism and two three-prism spectrographs (one being a slitless instrument). The distribution of coronium was found to be very different from that of hydrogen and helium. The line at λ5303·0 showed that it extended to a distance of about one solar diameter above the sun's surface, and the condensations in the green coronium ring as shown by the objective-prism plates indicated a distribution which was not in any way related to individual prominences. There appeared to be a general correspondence in the distribution of coronium and the main features of the corona, since it was faint or absent in the regions occupied by the polar "streamers" and abundant beneath the main extensions of the corona. The arches over prominences were unusually well developed, but the presence or absence of coronium in them could not be verified. The principal results are described by Slipher in the *Astrophysical Journal*, 55, p. 73.

Determination of Luminosities by Spectrophotometry.—Two new methods for determining stellar absolute magnitudes are described by Lindblad in the *Astrophysical Journal*, 55, p. 85. The first of these is applicable to stars of higher spectral type than those for which Adams's spectroscopic method is available, and is based on the variations, with absolute magnitude, of the energy distribution of the spectrum between H_ϵ and H_ζ. The two regions $\lambda\lambda$3889-3907 and $\lambda\lambda$3907-3935 are compared, and faint stars found to show a considerable relative decrease in intensity of the former region when compared with bright stars. This is probably due to the widening of $H\zeta$ and of some arc lines of iron and silicon. The actual measurements are made by taking a series of exposures of each star on the same plate with decreasing exposure-times. In the series of images thus obtained two are selected such that the intensity of $\lambda\lambda$3889-3907 in one is equal to that of $\lambda\lambda$3907-3935 in the other; and the ratio, E, of the two exposure-times is plotted against the absolute magnitude, M, of the star. Curves are given showing the relation between log E and M for different types, and it is claimed that for types B_8-A_3 absolute magnitudes may be found (with the dispersion used) with a probable error of only $\pm 0{\cdot}4$ mag.

The second method is similar to the first, but is only applicable to stars (types G-M) in which there is appreciable cyanogen absorption. The relative density on either side of λ3889, and between the regions $\lambda\lambda$4144-4184 and $\lambda\lambda$4227-4272 are found and compared as above with the absolute magnitudes of the stars.

Research Items.

MENTAL TESTS AND MENTALITY.—At the present time when, owing to the exigencies of practical life, some method is needed whereby individuals can be selected rapidly and effectively for specific tasks, the question of mental tests is a serious problem. Selection by examination, by influence or personal opinion has been found to be inadequate, and so there is a tendency to expect too much from the alternative method known as mental tests. In *Psyche* (Vol. II. No. 4) Prof. Pear raises some very interesting problems connected with such tests. He insists that intelligence tests indicate only one kind of mental capacity; they are an attempt to provide a quantitative indication of some mental trait. In practical testing, however, the tester often ignores the characteristic apparatus possessed by the examinee; even though two people may be assigned like marks for a test, in actual life it may matter seriously whether the result was attained by the use of visual imagery, kinæsthetic imagery, verbal formulæ, or imageless thinking. Again, the attitude of mind of the examinee must be considered; a genius might display apparent lack of intelligence because he saw in the problem many more complications than the ordinary person, and the typical extrovert will react quite differently from the typical introvert. Lastly, the author discusses the problem of stupidity both intellectual and emotional, the latter type having been very much neglected. The paper is both critical and suggestive, and will be of interest to workers in this field whether from the educational or industrial aspect.

LIGHT REQUIREMENTS IN HOSPITALS.—At a joint meeting of the Illuminating Engineering Society and the Royal Society of Medicine on April 27 the lighting of hospitals was discussed. The subject presents many interesting problems, and has not yet received sufficient attention. Mr. J. Darch, who presented the introductory paper, showed a variety of illustrations of methods of lighting wards devised to avoid glare from lights shining in the eyes of patients—apparently a common fault in hospitals. He also discussed the lighting of operating tables where somewhat complex requirements exist, including a very high illumination, freedom from troublesome shadows cast by the person of the operator, and elimination of the possibility of dust falling from the fixture during an operation. A value of not less than 25 foot-candles on the operating table was suggested. Reference was also made to natural lighting, the somewhat revolutionary proposal being made that the operating theatre should be located at the top of the building so as to secure maximum daylight. A number of medical men and ophthalmic surgeons joined in the discussion. Mr. Conrad Beck contributed an analysis of the requirements to be met in microscope illumination. The suggestion was made that "artificial daylight" units would prove very serviceable in cases where correct appearance of colours forms an important feature in diagnosis. Mr. J. B. Reiner showed some compact forms of inspection lamps where the provision of a sufficiently bright and uniform illumination, without striations, presents difficulties. Prior to the discussion a series of queries relating to problems met with in hospital lighting had been drawn up and circulated, and Mr. Gaster suggested that these might form the subject of study by a small joint committee.

THE ORIGINS OF EXISTING CORALS.—Prof. P. C. Raymond ("The History of Corals and the 'limeless oceans,'" *Amer. Journ. Sci.*, vol. 202, p. 343, 1921) traces the hexacoralla back to Walcott's *Mackenzia costalis* from the Middle Cambrian of Burgess Pass, British Columbia, a limeless form first described as a holothurian, and referred to the actinians by H. L. Clark. Its modern representative is found in Edwardsia, an inhabitant of sandy shores. Prof. Raymond regards all the Palæozoic corals that adopted the habit of secreting—or, from the present point of view, excreting—calcium carbonate as tetracoralla. These were killed off in the cold waters of the Permian glacial epoch, leaving the Edwardsian line to pass on into a large number of hexacorallan types with calcareous skeletons, which first become prominent as reef-builders in Middle Triassic times. At this period, the warmer waters contained more salts, and the sedentary habits of the actinians decreased their power of elimination. These seem large conclusions to found upon the impress of a soft-bodied organism of Cambrian age; but palæontology at present glows warmly through the use of well-controlled scientific imagination.

GEOLOGY OF WESTERN SOUTHLAND, NEW ZEALAND.—The Geological Survey of New Zealand continues, in Bulletin 23, its admirable practice of combining geological description with illustrations of the scenery of the country. The fascinating South Island bids fair to be as well "visualised" by those who cannot travel as are the west central States of North America; and each new Bulletin issued by Mr. P. G. Morgan makes one wish that New Zealand could be floated nearer to its antipodal colleague on some favouring current of the "sima" (see Wegener's views, NATURE, vol. 109, p. 202). Prof. J. Park in No. 23 describes part of Western Southland, including Lake Te Anau, which simulates a fjord among the mountains. The deep dissection of the early Cretaceous peneplain that was worn across the folded masses of the New Zealand Alps has formed noble ravines like that of the Clinton River (Pl. III.), where intrusive diorites and granites, probably of Permian age, come to light. These valleys have been carved along Pliocene lines of fracture. Though Prof. Park gives a general summary of the geological history of New Zealand (pp. 25-28), he touches very briefly on the formation of the arc of which the axis of the islands forms a part. He significantly refers the folding and fracturing to compressive stresses set up by the sinking of the adjacent troughs; but he inclines to regard these troughs as very ancient and persistent features. One would like to know if the present islands, as a ridge between the great eastern and the shallower western deeps, owe their existence above sea-level to a Pliocene creep of the ocean-floor resisted by an unseen extension of the Australian block.

CLOUD FORMS.—An article by Prof. W. J. Humphreys of the U.S. Weather Bureau on "International definitions and description of cloud forms, and supplementary remarks" is given in the March number of the Journal of the Franklin Institute. The article, which is continued from the February number, is based on a lecture on "Fogs and Clouds," given before the Section of Physics and Chemistry of the Franklin Institute on January 5 last. The different forms of cloud are well illustrated from photographs, many of which are new so far as cloud illustrations published on this side of the Atlantic are concerned. Cirrus clouds, from their light formation, are usually very difficult to represent in published form, but the illustrations given are good. Cirrus, which is the highest cloud, is said to occur at a height, approximately, of 5 miles in polar regions, 7 miles in middle latitudes, and 9 miles within the tropics. Many of the photographs

were taken from Mount Wilson and other heights. A cumulus formed by convection over fire is exceedingly good, and several lenticular cloud specimens are of interest; types are given of the funnel cloud or tornado cloud. The height of clouds is discussed, and it is said that they are lower during winter than during summer, due to the difference in relative humidity. The extension of our knowledge of the upper air has added much to the better understanding of cloud development.

Electrolytic Dissociation.—The Journal of the American Chemical Society for April contains an interesting paper by Prof. T. W. Richards and A. W. Rowe on the heats of neutralisation of alkalies with monobasic acids at various dilutions. As is well known, the approximate equality of the heats of neutralisation of strong acids by strong bases, indicating that the same reaction took place in all cases, namely, the union of hydrogen and hydroxide ions to form undissociated water, was one of the strong arguments for the theory of electrolytic dissociation put forward by Arrhenius. The careful measurements described in the paper show that the heats of neutralisation are slightly different, but since they all tend to the same limit with increasing dilution this is almost certainly the result of slight differences in the extent of ionisation of the different acids, bases, and salts. In solutions containing 100 grm. molecules of water to one of acid and base, the heats of neutralisation varied from 13·75 to 14·09 kilogrm.-calories. The heat of formation of water from its ions is found by slight extrapolation to be 13·62-13·69 kilogrm.-calories at 20°, in good agreement with the value 13·7 adopted by Arrhenius. These results would seem to rule out the assumption made by Ghosh and others that these electrolytes are all equally dissociated at the same dilution, and in a paper in the same journal by Prof. J. Kendall the theory of Ghosh is also adversely criticised from other points of view.

The British Beet-Sugar Industry.—In 1745 the Berlin chemist Margraaf discovered sugar in the beet, and in 1812 Napoleon laid down 75,000 acres for the cultivation of beet and established six centres of instruction. This was the result of the Continental blockade. Immediately before the outbreak of war in 1914, France and the United States each had half a million acres under sugar-beet, Germany had a million acres, and Austria, Belgium, Denmark, and Holland also made important contributions to the industry. Great Britain had only one factory, at Cantley in Norfolk, under Anglo-Dutch control. In the Journal of the Society of Chemical Industry for April 15 an account, with excellent illustrations, is given of the beet-sugar works at Kelham, Notts, owned by Home-Grown Sugar, Ltd. This works, which was designed by a French firm, and is almost entirely staffed by French workmen and managers, was the result of a grant of money from the Treasury. Up to date there has been a large deficit on the working of the factory, but as a result of the arrangement with the Government to remit the duty until the company is in a position to produce a total of 50,000 tons of sugar a year, it is hoped that progress will be made. The process is identical with that used in the North of France. Sugar-beet has been cultivated on 230 acres, and some 2300 acres have been grown locally by farmers, an average of 5·5 acres each. The sugar content of the roots has reached 15·92 per cent. The roots are washed, sliced mechanically, and treated with water in diffusion apparatus at about 70° C. The extract contains about 12·5 per cent of sugar, and the residue, after drying and mixing with molasses, is sold for stock feeding. The aqueous extract is treated with milk of lime and then with carbon dioxide to precipitate the lime. The clear liquor, after filtration, is treated with sulphur dioxide, evaporated *in vacuo*, cooled, and the crystals drained in centrifugal machines.

A New Desensitiser.—We learn from the *British Journal of Photography* of May 5 that Dr. E. König, of the Hoechst firm of Meister, Lucius, and Brüning, who was associated with Dr. Lüppo-Cramer in his work on desensitisers of photographic emulsions, has continued the work on this subject. The practical result is that he has obtained a desensitiser fully equal in its effects to phenosafranine and without some of its disadvantages. The new desensitiser is called "Pinakryptol" and is a greenish-grey mixture of two desensitisers. One part is dissolved in 5000 parts of water for use, and its notable advantage is that it has no staining action on gelatine or celluloid or the fingers or nails of the user.

Petrological Microscopes.—We have received from Messrs. James Swift and Son, Limited, a catalogue of their petrological microscopes. The excellence of their work has earned them a well-deserved reputation which is still maintained. A number of types are described in the catalogue, some with a rotating stage and others with rotating nicols as originally designed for the firm by Mr. Dick. The former include the "Primex" for the use of elementary students, the "Advanced Student," the "Petros," and the "Survey." The "Petros" has a hinged analyser, which can be brought into position above the ocular. This has the advantage that a quartz-wedge can be introduced in the focus of the ocular. In the remainder the analyser is inserted in the lower end of the body tube, but a second analyser, which can be placed above the ocular, can be purchased as an accessory. In the "Advanced Student" the convergent system fits into a sleeve above the polariser, but the top lens can be removed if a less convergent system be desired. This arrangement can, however, be replaced by the convenient swing-out screw focussing adjustment which is fitted to the more expensive "Petros" model. The "Survey" is distinguished by its well-equipped substage. In all except the "Primex" there are two Bertrand lenses for the observation of interference figures, one at the upper end of the tube for measuring comparatively small crystals, and the other just above the objective, giving a much larger image. A more advantageous course is to employ, instead of a Bertrand lens, an auxiliary lens above the ocular. The light coming from a small crystal or part of a crystal, which it is desired specially to examine, can first be isolated by a perforated diaphragm in the focus of the ocular and the auxiliary lens then placed in position, when the interference figures can be observed unaffected by extraneous light. This procedure was recommended by a committee of the British Science Guild, and excellent auxiliary lenses of this description have been prepared by Messrs. Swift, which might have been expected to have had a place in this catalogue. Two types of microscope with rotating nicols are described, the well-known "Dick" microscope, and the "Grabham-Dick," distinguished by the triple nose-piece beneath the stage, which makes it possible to place three different types of condenser in position in turn. Full particulars are given, in the concluding pages of the catalogue, of different objectives, nose-pieces, centring objective changes, and other necessary or commonly employed accessories manufactured by the firm. It should have been stated in the case of quartz-wedges whether they are graduated to show the relative retardation at different points.

The Rat and its Repression.

By ALFRED E. MOORE, Hon. Director of the Incorporated Vermin Repression Society.

RATS have for more than three thousand years been regarded as noxious vermin by man. Boelter[1] reminds us that the Egyptian cat, *F. Caffra* (*Caligata* or *Maniculata*) was a domestic animal in Egypt twenty centuries B.C. and that it was held in the highest reverence as a natural protector of grain from rats and mice. Boelter relates how, when Ptolemy was doing all he could to conciliate the Roman power, a Roman accidentally killed a cat, and Diodorus Siculus, an eye-witness, tells how nothing, not even the terror of the Roman name, could save the unlucky Roman from punishment. To-day, when the rat army numbers almost countless legions, we find an apathy that is appalling, a stagnation of effort which is allowing the rat to encircle the earth, and like a creeping paralysis to leave death and destruction in its trail.

It is not so important to fix geographically or historically the origin of the rat, as it is to realise the fact that this rodent now inhabits practically every place where man has a dwelling, and that of all animals it is most fitted by nature to serve as a human scourge. Apart from the astonishing prolificacy of the rat, the animal is furnished by nature with first-class engineering and excavating tools in the shape of wonderful hand-like paws, a pair of incisor teeth of razor-like cutting power and hardness, a tail which serves a variety of uses, and a brain nimble, cunning, and educable. These advantages plus a courageous and adaptable disposition have served to make the rat ubiquitous.

It has been urged that all rats are cannibals and that the brown rat (*Rattus Norvegicus*) in England has driven out the black rat (*Rattus Rattus*), but too much reliance cannot be placed on these assumptions, for rats are cannibals only when driven by unsatisfied appetite, and it is doubtful if the number of black rats in any area in England is such as to diminish the food supply of the brown rat and force it to become an active cannibal, or, on the other hand, that the sexual appetite artificially stimulated under the Rodier system can diminish appreciably the number of rat hordes.

It is, of course, fairly easy to invite a charge of exaggeration when dealing with the rat, for the pest is without doubt a grave menace; it has been said by Dr. Khunart that the rat must be destroyed, or it will destroy man. Insistence on the serious character of the problem makes it extremely difficult, however, to wage an effective war on the animal; for it is easy to secure the label "crank" and to lead the man-in-the-street to remark that, if it be true that the rat is such a terrible fellow, "it's a wonder we are alive." Prominent leaders of thought in the veterinary world regard the rat as a disease carrier *par excellence*, and I am convinced that further research will establish the rightness of many suspicions, but for the moment let us consider the nature of proven charges. We know, for example, that rats transmit plague, trichinosis, malignant jaundice, parasitic mange, and rat-bite fever, and we know that these maladies are serious diseases. They are, of course, calculable in effect, but there are other human ills directly attributable to the presence of the rat, such as loss of sleep through nervousness, fright, etc., and these ills are burdensome in so far as that they contribute materially to the sum of factors in physiological fatigue and therefore occasion incalculable loss of human efficiency.

Economically, the rat is a charge upon the resources of the nation, which is only measurable in figures too great to be comprehended by the casual student. We know that rats commence to breed when three months old, that the female litters from 6 to 12 times a year, and that the litter consists of from 6 to 12 young; therefore, we have a population of about 1000 rats from one pair of rats in 15 months, and as a rat costs approximately 1½*d.* per day for food it will readily be seen that we are paying too dearly for this pest. How much we are paying will be more clearly realised when we remember that it is generally agreed that the number of rats equals the human population; in some cases the rat population is considerably greater, as at a sugar plantation in Porto Rico, where the population numbered less than five hundred people and a six months' rat drive accounted for 25,000 rodents killed. Bearing these numbers in mind, and taking the population of the British Isles as being about 47,000,000, we get a rat cost of as much as 75,000,000*l.* per annum after deducting ½*d.* per day per rat for garbage eating.

This is not, however, the total amount of taxation the rat imposes upon us, for it is my experience that the animal does an enormous amount of damage in pursuit of its food, and in poultry yards its depredations are very considerable. "Lantz (U.S.A.) quotes a Washington merchant to the effect that rats gnawed a hole in a tub containing 100 dozen eggs, and within a period of two weeks carried away 71 dozen without leaving either shell or stain." Cases are not rare where rats have disposed of half a lamb in a night, and it is an undoubted fact that if meat is condemned as tuberculous or unfit for food, rats seem to have an uncanny instinct for finding and consuming such portions of the carcases as are diseased.

It must not for one moment be imagined that fear of the rat is a fad, nor is it peculiar to the medical profession: medicine, hygiene, and commerce all have contributed men with international reputations—Crichton-Browne, Andrew Balfour, Arthur Shipley, Glen Liston, Mark Hovell, Akin, Pasteur, Creel, Emil Zuschlag, Hinton, Bruce Bruce-Porter, James Cantlie, Frederick Hobday, Banister Fletcher, Castellani, Nathan Raw, Sydney Hickson, Tanner Hewlett, and Lords Denbigh, Aberconway, Lambourne, Ernle, and others too numerous to mention have joined their voices to those of the informed public and members of Parliament in a call for rat repression, as a measure of public safety.

It is significant that the first determined effort to deal with the rat in England found definite shape in ordinances made in various parishes in 1740 and again in a Bill introduced into the House of Commons by Sir Chas. B. McLaren in March 1909, and reintroduced by him into the House of Lords, some ten years later, where he sat as Lord Aberconway. Although in common with America, Japan, Denmark, Sweden, Barbadoes, Antigua, and Hong Kong, we in England have now an anti-rat law, there is much amendment required to make it effective.

[1] "The Rat Problem," by Wm. Boelter. John Bale, Sons, and Danielsson, Ltd.

There are no financial provisions for the Rats Act's working to be found in the Act; it is punishable with a fine to harbour rats, yet reinfestation of a cleared habitation is not punishable, nor is trafficking in rats a crime. These weaknesses are being remedied in a Bill being drafted by the Incorporated Vermin Repression Society to amend the existing Act. The I.V.R.S. memorialised the League of Nations, and incidentally the memorial was signed by leaders of all shades of thought, with the view of securing an International Conference to deal with rats and shipping (the existing regulations being chaotic and tending to discriminate against this country) and to give a ruling on the vexed question of the employment of virus.

The virus question is one that should be settled without delay. Those—like the I.V.R.S.—who oppose its use, argue that it is unsound in principle to permit the unrestricted use of living virus, or germs, of mouse typhoid or any other disease which might possibly become communicable to man, and that, moreover, it is a waste of money and opportunity to create a race of rats immune to the effects of virus in the process of killing what is, after all, an infinitesimal proportion of the rat population. Attempts to get manufacturers interested in the production of virus to agree to a round table conference with unbiassed bacteriologists, pathologists, Government representatives and business men, have unfortunately, so far, been unsuccessful.

The question is often asked—"What is the best method of destroying rats?" There is only one answer—"There is no *best* method of destroying these pests." Rat destruction is a problem of urgency, and also one of extreme difficulty, and a moment's reflection shows that this difficulty cannot be dismissed with a shrug of the shoulders, because the rat is far too clever to be caught except in negligible numbers by any crude method. It is an omnivorous feeder, and since the rat's diet comprehends bacon, bananas, eggs, lamb, young chicks, offal, bread, sponge-cakes, young rabbits, young game, biscuits, human flesh, apples, sweetbreads, corn, bulbs, and other eatables too numerous to mention, it is hopeless to pin one's faith to poisoning, since all poisoning, that is to say, effective poisoning, is a matter of baits. Again, this method of destroying rats demands fool-proof preparations, which limits the field in this respect; obviously it is dangerous to place poisons such as arsenic, strychnine, antimony, phosphorus and the like in places accessible to children or domestic animals; therefore, for all practical general purposes we are limited to barium carbonate, squill, and sodium fluoride. Cats and dogs are very useful, but it is a mistake to assume, as does one port authority, that an excellent sufficiency of cats is a good insurance against rats; as a matter of experience it is nothing of the kind, for, like practically all domesticated animals, the cat is companionable, and unless it has a spare diet, and is deprived of the association of too many of its kind, it becomes a hunter after the fleshpots of Egypt rather than a menace to rats. Ferrets are useful only in the hands of practical rat-catchers; for in unskilled hands they get lost. Nevertheless, since they are useful in skilled hands, they may render excellent service to the community when they are associated with a game terrier in an anti-rat club, and such clubs should be a feature in every village and rural town. Gassing, too, has its advantages, sulphur dioxide being perhaps the safest to use, but as a lethal agent it is inferior to chlorpicrin gas. The U.S.A. Government report favourably on a gas called cyanogen-bromide. There is much to be said for the raising of the status of those who are engaged in the war against rats; for modern drainage systems, while aiming at efficient sanitation, undoubtedly provide excellent facilities for rat locomotion, and tend to defeat the object of rat-weeks by allowing the hard-pressed rats of one district to escape to another district where the rat-week is next week. The vast emporiums, too, provide problems in rat repression which no ordinary rat-catcher can grapple with effectively. To sum up, if rats are to be appreciably diminished in number it is imperative that—

(1) An International Commission be created to extract the best of all existing rat laws and codify them in such a manner as to ensure their being concurrently effective in all countries, and in all ships and vehicles of water transport.

(2) Our own rat laws be amended: (*a*) to make rat trafficking a crime; (*b*) to make rat reinfestation a crime; (*c*) to make financial provision for the carrying out effectively of the rat law; and (*d*) to make it an obligation upon the Ministry charged with the administration of the Act to enforce its being carried out by the authority concerned.

(3) All *bona fide* rat-catchers be registered and given instruction in elementary pathology, sanitary engineering and hygiene, and certificates be issued to competent and honest persons engaged in this business, withdrawable publicly in the Press in the event of petty larceny, offences against the Rats Act, or for other specified reasons.

(4) The question of the use of virus should be settled, and whatever conclusion is arrived at in this regard be given the widest publicity.

(5) Twice a year all British authorities be compelled to co-operate and synchronise their efforts in rat destruction, and during the period, public lectures on rat destruction, rat proofing, and the necessity for eliminating possible rat-breeding grounds, be organised by the authorities.

(6) The authorities responsible for the zoological laboratories of all universities, colleges, and institutes be invited to set apart a portion of their time for the teaching of economic biology in so far as it concerns the rat, the diseases it carries, its movements, the nature and extent of its depredations, its natural enemies, and the known poisons which are safe to use, this with the view of discovering improved methods of ensuring its destruction.

(7) In all elementary schools pupils be taught the life-history of the rat, regarding the rat as man's natural enemy, the toxicity of the various raticides in common use, the value of the barn owl (*Strix Flammea*), the ferret, the weasel, the common kestrel, and the pine marten, the use of baits, varnishes, traps, the progress made by gassing as a method of rat destruction in ships and in places where it is possible to confine the gas, and the best methods of destroying rats (by water-flooding) in their runs, an effective method of killing rats in the country.

(8) All local authorities should frame their bye-laws so as to encourage rat proofing, and all employers of labour should exhibit in canteens, etc., a card, 12 in. × 10 in., warning their employees against leaving about the debris of food, and a reminder: "No scraps, no rats."

It cannot be urged too strongly that of all remedial measures against the rat, the most important are rat proofing and the withholding of food and water, especially water, for rats can exist much longer without food than without water.

Science and Gas Warfare.[1]

I LOOK upon it as a great honour to have been invited to come here to-day, and I appreciate the compliment which has been paid me. It was my privilege to be associated with many of the leading British men of science during the war, and, if I may say so without presumption, I regarded them with the greatest admiration. I was intimately connected with certain phases of their work, and I was also brought into contact with the war work (carried out on the same lines) of most of our allies, as well as of our late enemies: and while implying nothing derogatory to the latter, I have no hesitation in declaring that in the matter of practical achievement British men of science were second to none.

The war was one in which science played a part which increased progressively in importance: and the Empire owes a debt, the extent of which perhaps it does not fully realise, to the able scientific workers who gave their services—often in an honorary capacity—in solving the various vital problems which were put before them—problems in preventive medicine, optics, sound-ranging, aeroplane design, chemical warfare, and so on: and to the scientific institutions all over the country which provided them with facilities for their researches.

It is not surprising to find that this College, with its Imperial associations and great record of public service, took a leading part in this work—the work of winning the war. A prominent feature in the Nominal Roll of the College is the variety of the service which was given by its past and present students. Their names appear in every department of army activity, but more especially in the various branches of my own Corps, the Royal Engineers. We have been called the scientific Corps; but while not pretending that this is an accurate description, we are, and always have been, at any rate the link between the army and the scientific world, and I think I can claim that we are very receptive of all scientific proposals and alive to their developments. Many of the students of this College served in that branch of the Corps with which I was most intimately concerned, and the names of some of them are engraved on this tablet.

Owing to the secrecy which it was necessary to maintain during the war, the general public has still, I believe, little idea of the prominent part which chemical warfare played on the field of battle on the Western Front. Between the Battle of Loos, in September 1915, and the armistice, the activity of the Special Brigade was almost incessant, and gas attacks were carried out on an average on two nights out of every three during the whole period. Some 800 separate attacks were made—against about 25 by the Germans against us—and nearly ten thousand tons of gas were liberated, quite apart from the work of the artillery: and many were the variations practised in the form of attack, as regards tactics, mechanical appliances, and meteorological conditions.

The enemy's casualties from these gas attacks probably numbered between 100,000 and 200,000, amongst whom the percentage of mortality was very high. These operations were carried out, for the most part, by young students fresh from civil life, who had had little preparation for the work and practically no military training whatever. In spite of the heavy artillery bombardments to which they were subjected—the retaliation for which each gas discharge was the signal—these young men combined with their technical skill a standard of personal courage worthy of veteran soldiers: and many distinctions were conferred on them, including the Victoria Cross. But it was not only in the front-line trenches that British men of science distinguished themselves in France. When the Germans launched their first gas attack against us in April 1915 our soldiers were unprepared and quite unprotected: and it must remain one of our proudest memories that they stood at their posts, and hundreds of them died there: it was due to the initiative and the energetic action taken by your Rector, Sir Alfred Keogh, then the head of the Medical Service at the War Office, and the steps devised by Prof. Haldane of Oxford, Prof. Baker and the late Prof. Watson of this College, and Prof. Jones of Manchester—then a private in the London Scottish—that the lives of thousands of British soldiers were saved in the course of the next few weeks. The protective appliance then extemporised was gradually developed in efficiency, chiefly by the late Lt.-Col. Harrison, until it became eventually a very perfect apparatus, millions of which were issued to the American and Italian armies as well as to our own.

This, however, was not the only scientific work undertaken for the protection of our troops. Knowing that we were only on the threshold of scientific discovery in its relation to gas warfare, we were always keenly sensitive to the appearance of any new chemical substance on the field of battle. In order to recognise it immediately it appeared, and to take the necessary steps to combat it, a very efficient chemical intelligence department was organised—quite separate from that which served the General Staff. A gas officer was appointed to each division in the field, one of whose duties it was to report all German gas attacks and bombardments—by telephone, and during its actual progress if it was an important one. If any novel symptoms of gas poisoning appeared anywhere on the front an able physiologist, who made a speciality of this work, went immediately to investigate them. If a new gas shell was suspected, samples of earth and water from the shell craters were collected for analysis, and an unexploded shell-case was located and dug up as soon as possible and sent in to a central laboratory for examination.

Opening these shells, the contents of which were often under pressure, was difficult and dangerous work: and I have little doubt that it was owing to his personal devotion to it, and the complete disregard of his own safety, that the late Prof. Watson, who was the Director of this laboratory, sacrificed his health, and eventually his life. I think it would interest you to hear that such was the efficiency of this chemical intelligence service that when the Germans first introduced mustard gas—then practically an unknown substance—warnings were telegraphed to all our armies, tabulating the injuries caused and the precautions which should be taken to avoid them, while an approximate analysis of the contents of one of the shells had also been made—all between 24 and 48 hours of its first use. When we came to summarise our knowledge of mustard gas at the end of the war, after a further 18 months' experience of it, it was found that there was little that could be added to the statement originally issued.

In conclusion, I ought not to omit reference to the devoted work done at home in connection with chemical warfare in the various research laboratories and munitions factories all over Great Britain. One of

[1] Address by Col. C. H. Foulkes when unveiling the War Memorial of the Royal College of Science on March 29.

our gas factories was closed on certain occasions for days at a time because most of the workers were put out of action, suffering from gas poisoning: there were other similar incidents, and in a number of cases men lost their lives; which shows that service at home was by no means without its risks. In fact, I might almost say that work in a poison gas factory entailed suffering from gas poisoning sooner or later.

In research work, Profs. Baker and Thorpe were very prominent throughout the whole period of the war. They, with other eminent men, gave themselves whole-heartedly to this work, to their own financial disadvantage, and without the prospects of reward which the successful soldier has in view. In science, at any rate, there was no profiteering. A lady of this College, Dr. Whiteley, introduced the use of "S.K."—symbolising South Kensington—a substance that was largely used against the Germans—as well as a new explosive.

In all the preliminary physiological tests, of course, animals were used; but volunteers were never wanting for the more important experiments in the lethal chamber: and at one time many of the experimental staff at Porton were in a constant state of ill-health owing to the trying nature of this work. One gallant action worthy of record was that of Mr. Barcroft of Cambridge, who, in order to confirm a theory which had an important bearing on our gas tactics, entered the lethal chamber together with a dog, both being entirely unprotected, and remained there while exposed to prussic acid gas until the dog died.

All honour, then, to the distinguished scientific workers of our nation in general, and of this College in particular, staff and students, who responded to the call of patriotism on the battlefield, in the committee-room, the research laboratory, and the munitions factory; but, above all, let us hold in grateful remembrance those whose names are inscribed on this tablet, who not only served their country to the best of their ability, but who gave their lives in doing so.

The Evolution of Plumage.[1]

THE paper by Prof. Ewart referred to below contains much good and new matter, but the good observations are not exactly recent discoveries, whilst the new conclusions and speculations are rather contestable, or at least startling.

The bulk of the paper is very technical, but some of the generalisations concerning the evolution of the coat or coats of feathers of birds never fail to interest a wider circle of readers. The first coat of the young chick is composed of structurally rather simple little feathers, the Neossoptiles or nestling feathers; the final or finished feathers were called Teleoptiles. The first set is structurally continuous with the next growing set or generation. Then it was found that in the majority of birds not one but two nestling coats were successively developed, both in structural continuity with each other (henceforth distinguished as Proto- and Mesoptiles; and the latter passing into the Teleoptiles).

These several sets or generations vary much in relative importance, time of their emergence or growth, size and temporary functions, in the different groups of birds. For example, whilst the first set forms the duckling's first and effective jacket, it is the second set which in the penguins makes a very woolly and warm coat which lasts the youngsters many months, until these fluffy down-like feathers are supplemented by typical adult feathers. Moreover, in the duckling this second set is in the interesting condition of reduction, being practically crowded out of existence between the first and the third set. It depends upon the group of birds whether and how and to what extent these Mesoptiles become vestigial.

Again, while in ducks and penguins—in fact, in the overwhelming majority of birds—the difference between their nestling coat and the final dress is enormous (let us remember the callow blind-born nestling of a thrush, with a few large wavy tufts, before the final feathers begin to sprout), in the cassowaries and emus the differences between the successive coats are reduced to a question of mere size. In short, the variations are almost endless and still promise many new discoveries, all the more interesting when correctly correlated with the bird's ecology. Indeed, here is a wide and fertile field for fascinating speculation. Let us see how Prof. Ewart has tackled the matter. The chapters dealing with a more general account of the evolution of the plumage are an instance of that kind of "Natur-Philosophie" which, entranced by the new Darwinism, did not allow itself to be hampered by facts nor to be checked by the perhaps equally sanguine speculations of others.

Although the earliest birds known are the two specimens of Archæopteryx from the upper Jurassic, our author states that at the beginning of the Jurassic age the coat of birds may have consisted only of Protoptiles; and the scene of the dawn of feathers of such low order is set in a land with desert climate, cold and dry, atmospheric conditions which would engender feathers. The dryness would cause the hypothetical feather "filaments" or cryptoptiles to split or fray into a kind of brush, and "whatever bird or beast became warm-blooded would appreciate an overcoat." Presumably the creature became heated by its attempts to flutter, and the increased temperature made it liable to catch cold and call for a feather coat. Thus a teleological unscientific notion is preferred to the suggestion that a gradually improving coat (and frayed brush-like scales would be less heat-conductive than ordinary reptilian scales) might induce first stable and then permanently increased blood-temperature. Surely the important feature would be the thermostatic result, resulting incidentally from the development of a better non-conducting coating.

In any case this first set of little Protoptiles formed at best a poor sort of flimsy overcoat. When, however, the climate changed from cold and dry to cold and damp, "during perhaps a cold phase of a glacial epoch," the coat was changed into the Mesoptile coat by the lengthening of the previously existing branches, or barbs, of the brush, and by the sprouting of new additional barbs. At any rate thus was evolved the thick, fluffy, warm coat of the young penguins, and it "is probably as useful now to the penguin chicks hatched within or near the Antarctic circle as it was when originally acquired during perhaps a cold stage of a glacial epoch."

Later, as the climate improved [interglacial] this fur-like second coat was in most other birds more or less suppressed [perhaps it proved too hot] and a third coat was constructed out of what gradually improved into feathers proper, which in turn were differentiated into downs and contour feathers, and some of these became, through use, etc., specialised into remiges and rectrices. At last there was a chance for a flying bird. Ostriches and similar birds perhaps never did

[1] "Nestling Feathers of the Mallard," by Prof. J. Cossar Ewart, Proceedings, Zoological Society of London, 1921, p. 609.

live in a cold damp climate, and consequently never went through the intermezzo of a "British warm."

But which glacial epoch wrought all these miracles? The author, surely, does not mean the Permian glaciation; and certainly geologists tell us there was none until towards the end of the Tertiary. Perhaps the penguins had a Jurassic glacial epoch in their Antarctic realm, while owls and petrels, which, by the way, have as thick and fluffy and long-lasting Mesoptile coats as any penguins, owe these coats to our Pleistocene bad times. We can scarcely date these birds back into early Jurassic times like the penguins, which until their first interglacial ease-off must have waddled about without feathers proper, all their lives long moulting from one thick Mesoptile coat into the next, generation after generation. This truly startling picture results from the confusing of generations of feathers, which are ontogenetic items, and stages in the evolution of the plumage, which are phylogenetic conceptions.

Archæopteryx likewise does not fit into this view, with its highly specialised remiges and rectrices, of late Jurassic date, and certainly long before penguins came into existence.

Apropos of the question of the origin of feathers from scales, we are told that the conversion of his Cryptoptiles (consisting apparently of hollow epidermal cones) into the Protoptiles took place "in some incomprehensible way," and that the Protoptiles "in some way soon acquired the chief characteristics of true feathers." Perhaps it was a case of miraculous mutation? But why incomprehensible, considering that there are at least two reasonable possible explanations, the only difficulty being which to choose. What is less comprehensible is that the author did not refer simply to that résumé (itself a large essay) by that experienced referee Prof. Keibel, in "Ergebnisse . . .," 1896, supplemented more recently by Schleidt (1913) and Steiner (1918), who adds a literature list well-nigh complete and appalling by its size.

H. F. G.

The Advance of Heliotherapy.

By DR. C. W. SALEEBY.

THE treatment of disease by sunlight is the newest of old things. It was systematically practised by Hippocrates, the Father of Medicine, and perhaps we need not trouble ourselves with questions of priority in our own times. At any rate, the first clinic for the heliotherapy of surgical tuberculosis was opened by Dr. A. Rollier at Leysin in 1903, and at last it would appear that his methods are to be followed throughout the world. Already in France and Italy the sun cure is practised, and I recorded lately in NATURE (March 2) the finding of many heliotherapeutic institutions on the Riviera, from Cannes to San Remo. The city of Lyons wisely sends its sick children to the Villa Santa Maria at Cannes, and the Italians have recently established the Istituto Elioterapico which I found outside San Remo a few weeks ago. In our own country we have Sir Henry Gauvain at the Treloar Hospital, Alton and Hayling Island, and Dr. Gordon Pugh, at Queen Mary's Hospital for Children at Carshalton. In the United States, Rollier is being followed at Perrysburg, near Buffalo.

Now there comes an admirable volume[1] which clearly presages the advance of heliotherapy into Spain. The number of the journal in question is devoted to a series of articles in Spanish by Dr. Rollier and his assistants at Leysin. First of these is a paper by Dr. Rosselet, a physicist, on the scientific bases of heliotherapy, and Dr. Amstad contributes a paper on the sun cure of non-tuberculous diseases. We shall do well not to associate the sun cure exclusively with tuberculosis nor solely with the proved antiseptic power of sunlight. The recent American work, both at Columbia University and Johns Hopkins Hospital, has shown that sunlight has potent influences upon nutrition and metabolism, and is capable, for instance, of preventing and curing rickets in a fashion hitherto unsuspected. Amstad refers to rickets, of course, but he is evidently not acquainted with this new American work.

The publication is completed with a series of well-produced plates which illustrate Rollier's methods and show, in several "before and after" photographs, the all but miraculous results which he habitually obtains.

Madrid, like Munich and Mexico City, is a city which teaches us that abundant tuberculosis may occur even at high altitudes. Even "Sunny Spain" needs the lessons of heliotherapy. At Mentone, a few weeks ago, myself in broad and ravishing sunlight, I saw a cobbler at work in a dark room, lit by a miserable oil-lamp, the rays of which ill served to illuminate his work. Answers of this order serve as reply to those who ask why, for instance, if the sun be such a preventive, there is any tuberculosis in India.

In his fine article in this present publication, Dr. Rollier insists, as ever, upon the superior value of the early morning sun. This point needs perpetually to be made. We tend to associate light and heat; so that, last year, the late Prof. Benjamin Moore actually asked, in the *Times*, whether "too much light and heat" may not be bad for us. The question is illegitimate. Light and heat must be distinguished. In Canada, according to my own observation there, it is the combination of light and cold that contributes to the superb Canadian physique and vitality. In Switzerland the same is true, and Leonard Hill has shown us the physiological basis of this valuable combination. But when thoughtless clinicians expose cases of pulmonary tuberculosis, for instance, to sunlight in warm weather, perhaps in the afternoon, perhaps even with exposure of the chest, and achieve only fever and hæmorrhage for their unfortunate patients, we are told that heliotherapy is useless in phthisis.

It is certainly high time that the fundamentals of the biology and physiology of light should be well and truly laid. Dr. Rosselet, in his interesting contribution, does not convince us that any one, as yet, really knows how sunlight achieves its results, but we shall expect to place heliotherapy upon broad and deep foundations when the committee lately appointed by the Medical Research Council gets to work. Meanwhile we must hope for English translations of "La Cure de Soleil" and the rest of Rollier's works, so that the present tragic farce of the treatment of tuberculosis in this country, with its desolating results, may yield to the intelligent use of sunlight.

[1] Archivos Españoles de Tisiologia, Num. 4. (Enero 1922, vol. 2. Barcelona, Calle de Aragon, núm. 282.)

The Universities and the Publication of the Results of Research in America.

ONE of the principal subjects dealt with by the Association of American Universities in their conference last November was the publication of the results of research. Scientific and learned periodicals are numerous in the United States, and there has until the present been but little co-ordination. "The American Chemical Society," says the editor of the *Yale Review*, "now has under its management three journals: a monthly devoted to the theoretical aspects of the subject, another monthly devoted to industrial chemistry, and *Chemical Abstracts*, which reviews twice a month all publications carrying new contributions to chemistry in its various phases. The question of a similar consolidation has reached at least the stage of discussion in several other National Societies in order, not only to avoid duplication, but also to reduce overhead costs, and to bring together where it may be readily examined material that now lies hidden in hundreds of places and so may be easily overlooked." He suggests that universities might support periodicals published by such national societies in preference to establishing their own separate periodicals, and in particular, that instead of requiring dissertations for the doctor's degree to be published *in extenso* they should cause them to be "cut down to the bone" and the skeletons thus obtained to be given to the national societies for publication in their journals. The societies on their part might, he suggests, have their printing done by the University Presses.

An interesting sketch was given by the Director of the Wistar Institute for the Advancement of Biological Science of the operation since 1908 of a "plan for assembling and publishing a number of national zoological journals under one central management." So successful has this proved that the combined annual sales of five journals has increased from 1410 to 5286 copies, while the income has been gradually overtaking the cost, notwithstanding a lavish distribution of free copies, notably 5000 dollars' worth to the principal libraries of Europe—a policy begun immediately after the armistice was signed and to be continued for five years.

The factors of success are thus summarised: a whole-hearted co-operation of the men of science interested, whether as author, editor, publisher, or reader, a centralised management looking ever to prompt publication and extensive distribution with efficiency and economy, concentration on a group of journals limited to one field of research, and guarantee both financial and scientific of an endowed institution devoted to the same field of science. A feature of the Institute's methods of publishing the results of research is the system of "Bibliographic Service Cards." These include the author's abstract as well as complete bibliographic references, and an announcement of the date when the complete article will appear. They are issued fortnightly to subscribers to all the Institute's journals, and extra copies are often distributed for advertising purposes.

University and Educational Intelligence.

MANCHESTER.—The Council of the University has appointed Dr. Robert Robinson to the chair of organic chemistry which was vacant owing to the appointment of Prof. A. Lapworth to the chair of chemistry. Prof. Robinson graduated at Manchester University in 1905 with first-class honours in chemistry and was a graduate scholar and Le Blanc medallist. As research student, and later as a lecturer in organic chemistry in the University, a remarkable series of papers on natural plant products were produced in conjunction with Prof. W. H. Perkin and others. His synthetic work has also been singularly skilful. His work has been often concerned with the processes taking place in the living organism and has in many directions shown the way to development in biochemistry. In addition to his academic work, Prof. Robinson, as Director of Industrial Research to the British Dyestuffs Corporation, has gained experience of working conditions especially valuable to such an important centre of the dyestuff industry as Manchester. Prof. Robinson has previously held chairs of organic chemistry at Sydney and Liverpool, and the chair of chemistry at St. Andrews. He was elected a Fellow of the Royal Society in 1920.

THE Delegacy of the City and Guilds (Engineering) College has appointed Prof. C. L. Fortescue, of the Royal Naval College, Greenwich, to succeed Prof. T. Mather, who is resigning the chair of electrical engineering in the College at the close of the present session.

THE Dr. Edith Pechey Phipson post-graduate scholarship of the London (Royal Free Hospital) School of Medicine will be awarded in June. It is open to all medical women, preferably coming from India, or going to work in India, for assistance in post-graduate study. It is of the annual value of 100*l.*, for a term not exceeding three years. Applications for the scholarship must reach the Warden and Secretary of the School, 8 Hunter Street, W.C.1 by May 31.

RECENT appointments to the staff of the Technical College, Bradford, include Mr. R. E. Stradling, as head of the department of civil engineering in the college, and Mr. H. J. B. Chapple, as lecturer in electrical engineering.

APPLICATIONS are invited for the Ray-Lankester Investigatorship at the Marine Biological Laboratory, Plymouth. The post is of the value of 100*l.* and is tenable for fifteen months, out of which the investigator will be required to devote five months at the laboratory to some subject of marine research. Applications should be addressed to the Director.

A CONFERENCE of representatives of the Universities of Great Britain and Ireland was held on Saturday last, May 13, at University College, London, under the presidency of Sir Donald MacAlister, vice-chancellor and principal of the University of Glasgow. The discussion on advanced study and research was opened by Dr. J. C. Irvine, vice-chancellor and principal of the University of St. Andrews. Dr. Irvine expressed the opinion that research should be controlled in every university by a board or standing committee, with power to recommend changes in the teaching staffs of departments actively engaged in research, to allocate money voted for research purposes, and to consider such questions as travelling and publication grants.

Dr. L. R. Farnell, vice-chancellor of the University of Oxford, who opened the discussion on specialised study, stated that the idea of having one university for physical science and another for the humanities would be fatal to the cultivation of both branches of knowledge. On the other hand, it must be recognised that by reason of their surroundings, some universities were peculiarly fitted for certain studies. Mr. Fisher joined in this discussion, emphasising the growing need for co-operation between the universities, in respect of the distribution of studies according to the particular advantages of each. It was suggested that

a committee of vice-chancellors should investigate claims for additional endowments by special departments and inquire whether the transference of trust funds to different subjects within the university was desirable or whether the migration of students requiring special subjects could be facilitated. Sir Henry Miers, vice-chancellor of Victoria University, Manchester, was emphatic on the point that higher education of the right type could be given only by universities or institutions of similar standing.

IF the number of suitable applicants is sufficient, the Board of Education will provide during the summer, courses of instruction of two weeks' duration for teachers of engineering science and electrical engineering in technical schools. The standard of the work will be that of the "National Certificates" in engineering of ordinary grade, but advanced treatment will be accorded to certain sections of the work. The courses will start on Saturday, July 22, and will end on Saturday, August 5. The courses will be held in Oxford, in the University Engineering Building, the University Electrical Laboratories, and in the new laboratories of the City of Oxford Technical School. The instruction in engineering science will be given by Prof. F. C. Lea, of Birmingham University, and that in electrical engineering by Prof. W. M. Thornton, of Armstrong College University of Durham, each of whom will have the assistance of a staff of tutors, lecturers and instructors. Teachers who wish to apply for permission to attend either course must fill up and return form 972 T/Engineering as soon as possible, so as to reach the Board's office not later than Monday, May 29.

MR. J. W. BISPHAM, of the London County Council service (Technology Section), has been appointed principal of the Borough Polytechnic Institute, to fill the vacancy caused by the retirement of Principal C. T. Millis. He will take up his duties in September.

IN Bulletin No. 6, 1921, of the United States Bureau of Education, published for the guidance of students in other countries contemplating advanced study or research in the U.S.A., particulars are given regarding the graduate schools of 28 universities, including, *inter alia*, admission requirements, periods of study for degrees, noteworthy facilities for particular lines of graduate study (equipment and research funds, library facilities, and facilities for publication of research results), expenses of tuition and board and lodging. The graduate school now usually co-ordinates into one administrative unit all the advanced teaching and all the facilities for original research provided by the university. To obtain a master's degree, one year (Yale and Johns Hopkins—two years) of post-graduate study devoted, as a rule, to not more than three subjects, including one "major," is usually required, while for a doctor's degree the minimum period is usually three years. Most universities require the dissertation for the doctorate to be published. The requirements for the Ph.D. degree parallel closely those proposed by the German universities, but attempts have recently been made to insist on a somewhat longer scholarly preparation and a more substantial thesis. Each university generally awards to graduate and professional students a number of fellowships and scholarships carrying stipends ranging from 100 to 600 dollars, the holders of which are sometimes required to do one to six hours' teaching weekly. Foreign students will usually find it necessary to spend at least a year in residence at an American university before qualifying for one of these grants. The enrolment in graduate courses in the United States increased from 4340 in 1893 to 16,470 in 1916.

Calendar of Industrial Pioneers.

May 18, 1747. Bernardo Zendrini died.—One of the most celebrated Italian hydraulic engineers of the eighteenth century, Zendrini was also a mathematician and was one of the first to apply the infinitesimal calculus to practical problems. As mathematician and engineer to Ferrara, Modena and Venice he carried out many works connected with the rivers and ports of north-east Italy.

May 19, 1907. Sir Benjamin Baker died.—Born in 1840, Baker was apprenticed at the Neath Abbey Iron Works in South Wales, and after gaining experience as a civil engineer became an assistant to Sir John Fowler, with whom he was afterwards in partnership. Among the great works he was associated with were the Forth Bridge, the Assouan Dam, the Central London Railway, and the Avonmouth Docks. As one of the leading engineers of his day he served on the Ordnance Committee, the Engineering Standards Committee, was elected a fellow of the Royal Society, and in 1895 served as president of the Institution of Civil Engineers. A memorial window to his memory has been placed in the north aisle of Westminster Abbey.

May 21, 1826. Georg von Reichenbach died.—A famous German mechanician and instrument maker, Reichenbach was born in 1772 at Durlach. In his youth he spent some time at Boulton and Watt's works at Birmingham, and after his return to Germany was employed with his father in the manufacture of munitions. In 1800 he invented a dividing machine; the transit circle was re-introduced by him, and he collaborated with Utzschneider, Fraunhofer, and Ertel.

May 22, 1900. William Lindley died.—Trained as a civil engineer under Francis Giles, Lindley worked under Brunel on the Thames Tunnel, and in 1838 became engineer of the Hamburg and Bergedorf railway. He was afterwards responsible for the sewage works, the water works, and many of the engineering schemes which turned Hamburg into one of the greatest modern seaports.

May 23, 1800. Henry Cort died.—The inventor of the important process of puddling and also of the grooved rolls for manufacturing wrought iron, Cort, between 1765 and 1775, made a fortune as a navy agent in Surrey Street, the Strand. Stimulated by the dearness of Russian iron, he then made experiments on iron-making and had works at Fareham and Gosport where, in 1783, he brought out his great inventions, but at the same time reduced himself to poverty. His inventions added enormously to the wealth of the country, and the puddling process supplied all the malleable iron for our engines, railways, and iron ships till the introduction of the Bessemer process of making mild steel.

May 23, 1915. Pierre Emile Martin died.—A native of Bourges, and born in 1824, Martin in the early 'sixties began experimenting on the manufacture of steel in a small Siemens regenerative furnace, and in July 1865 took out his patent for the process in which pig-iron, scrap steel, and iron oxide are melted together on an open hearth. Till the introduction of the basic-lined furnace of Thomas and Gilchrist, the Martin—or Siemens-Martin process, as it is known in England—made little headway against the Bessemer process. By 1913, however, of 74 million tons of steel produced only 30 millions were produced in Bessemer converters and the remainder by the Martin process. Martin reaped no pecuniary advantage from his work, but in 1910 a fund was raised for him, and a few weeks before his death he was awarded the Bessemer medal.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, May 4.—Sir Charles Sherrington, president, in the chair.—C. **Shearer**: On the heat production and oxidation processes of the echinoderm egg during fertilisation and early development. The heat production during fertilisation and early development of the egg of *Echinus miliaris* has been measured by the differential micro-calorimeter, and the oxygen consumption and carbon dioxide output by the differential manometer. In one hour, 1 million unfertilised eggs (8 mgrm. egg N.) consumed 15·1 c.mm. of oxygen at standard barometric pressure and 14·5° C., and gave off 0·067 grm. cal. of heat. In a similar interval the same quantity of fertilised eggs consumed 86·4 c.mm. oxygen and liberated 0·397 grm. cal. of heat. The ratio of the heat production in one hour to the oxygen consumption gives a calorific quotient *Q*, which is 3·07 in the unfertilised and 3·22 in the fertilised developing egg-cell. Thus very little of the chemical energy liberated as the result of fertilisation is expended in bringing about the visible morphological structure of the developing ovum. The heat liberation, oxygen consumption, and carbon dioxide output of the ovum after fertilisation rise progressively during development, reaching the highest point when the free-swimming stage is reached.—Johan **Hjort**: Observations on the distribution of fat-soluble vitamins in marine animals and plants. The periodical changes in the size and quality of fish at different seasons of the year are associated with changes in the content of fat. In cod the changes in quality are demonstrated by inspection of the size of the liver, which is 50 per cent. "cod-liver oil." The liver of full-grown cod during the summer season, when the fish was feeding, weighed three times as much as in winter, during the spawning season. Seasonal variations in quality do not coincide with temperature variations, nor, in the case of the cod, with the availability of the animals which serve it as food. The distribution of fat-soluble vitamin in green algæ (Ulva), diatom-plankton, shrimps and prawns, and hard roes of herring and cod was studied. These substances had a marked effect in re-starting and maintaining the growth of rats, previously on a diet free from fat-soluble vitamin.—H. **Hartridge** and R. A. **Peters**: Interfacial tension and hydrogen ion concentration. The drop-weight method, which gives results similar to the capillary height and ripple methods, was employed for measuring the interfacial tensions. A decrease in interfacial tension between a fatty acid or glyceride and aqueous fluids occurs with increasing alkalinity of the aqueous fluid. It depends upon the concentration of the fatty substance in the oil phase, the presence of a certain concentration of alkali in the aqueous phase, and the hydrogen ion concentration at the interface. Only substances having a COOH group (free or combined, as tri-glyceride) gave these changes.—W. **Cramer**, A. H. **Drew**, and J. C. **Mottram**: Blood-platelets: their behaviour in "vitamin A" deficiency, and after "radiation," and their relation to bacterial infections. The absence of the fat-soluble vitamin from the diet leads, in the rat, in every case to a progressive diminution in the number of blood-platelets known as thrombopenia. Thrombopenia occurs before any obvious signs of ill-health appear. When profound thrombopenia has been established, addition of the missing vitamin A to the diet is usually followed by rapid increase in the number of platelets up to the normal. Exposure to radium produces lymphopenia, which is characteristic of vitamin B deficiency, and also, with large doses, thrombopenia. Animals generally recover rapidly if the application of radium is discontinued. If the number of platelets is reduced below a certain critical level—about 300,000 in the rat—the resistance of the animal to infection is greatly diminished and infective conditions develop spontaneously. Alterations in local or general resistance to the infection are associated with local or general changes in distribution of the platelets.

Royal Microscopical Society, April 19.—Prof. F. J. Cheshire, president, in the chair.—R. S. **Ludford**: Morphology and physiology of the nucleolus. Of the various functions which have been attributed to the nucleolus, recent work emphasises that it (1) represents secretory substances or enzymes elaborated by the chromosomes (chromatin) to bring about metabolic processes in the cytoplasm; (2) is the accumulation of waste products of nuclear activity which when extended into the cytoplasm are broken down with the liberation of energy, which is utilised for other purposes; (3) stands in some functional relationship to the morphological changes which take place in the chromosomes at different periods of cellular activity. There is considerable evidence in favour of each of these theories as to the function of the nucleolus.

Physical Society, April 28.—Dr. Alexander Russell, president, in the chair.—T. **Smith**: The position of best focus in the presence of spherical aberration. Focal variations of phase in the presence of spherical aberration are calculated directly from the axial intersection points of rays of known inclination. The new graphical method employed shows that the focus for which phase variations have a minimum value may be found and interpreted when the finiteness of the wave-length is disregarded.—F. **Twyman** and J. **Perry**: The determination of the absolute stress-variation of refractive index. The Hilger interferometer is employed in determining the stress-optical coefficients. Young's modulus of elasticity and Poisson's ratio are determinable simultaneously.—C. J. **Smith**: An experimental comparison of the viscous properties of (*a*) carbon dioxide and nitrous oxide, and (*b*) nitrogen and carbon monoxide. Direct comparisons have been made by observing the time required by a mercury pellet to force an equal volume of gas through a capillary tube at atmospheric and steam temperatures. The times of fall for each gas are equal at 15° C. and 100° C., and hence it is shown that the viscous properties are identical over this range. The absolute viscosity has been obtained by comparison with air, and the mean area of collision deduced by using Chapman's formula.—F. **Twyman**: An optical sonometer. The object of this instrument is to furnish graphs of the pressure variation in sound waves. The sound is directed by a trumpet upon a celluloid membrane a fraction of a wave-length of light in thickness, which is silvered at a point between its centre and periphery. Rays from a pointolite lamp are concentrated on the silvered surface, and are reflected thereby through an ordinary and a cylindrical lens on to a photographic strip carried by a spring-driven chronographic drum. The duration and incidence of the photographic exposure are controlled by adjustable devices revolving with the drum. The constants of the membrane can be determined by measuring its curvature with an interferometer when it is being stressed by gravity, pneumatic pressure or electrostatic attraction. Good sound records can be obtained so long as the pitch of the sounds investigated differs considerably from the resonance pitch of the membrane, which is of the order of 200 per second.

CAMBRIDGE.

Philosophical Society, May 1.—Prof. H. F. Baker in the chair.—H. **Lamb**: Waves of permanent type at the interface of two liquids.—A. E. **Western**: The number of primes of the form n^2+1.—S. **Chapman** and T. T. **Whitehead**: The influence of electrically conducting material within the earth on various phenomena of terrestrial magnetism.—Mr. **Ince**: The impossibility of the coexistence of two Mathieu functions.—V. **Trkal**: A general condition for the quantisation of the conditionally periodic motions with an application for the Bohr atom.—C. D. **Ellis**: Interpretation of the β-ray and γ-ray spectra. Taking a general view of a β-ray disintegration and of the radiations that accompany it, the β-ray line spectrum is entirely secondary in origin and due to the conversion of monochromatic γ-rays. The general β-ray spectrum and these γ-rays are the primary phenomena. This theory accounts for the thorium-*C* and radium-*D* spectra. Frl. Meitner's theory is unlikely to be correct; it offers no explanation of the general β-ray spectrum; it predicts that the total number of electrons emitted should be less than the number of atoms disintegrating; and, finally, certain lines in the radium-*B* spectrum should be primary and characteristic of the radium-*B* nucleus and therefore should not appear in the spectrum excited in lead by the γ-rays of radium-*B*. These lines, however, have been observed.

DUBLIN.

Royal Dublin Society, April 25.—Dr. G. H. Pethybridge in the chair.—W. E. **Adeney**, A. G. G. **Leonard**, and Miss A. M. **Richardson**: On the aeration of quiescent columns of distilled water and of solutions of sodium chloride. Columns of de-aerated distilled water and of sodium chloride solutions up to ten feet in length were exposed to a slow current of dry air for periods of 14-56 days. Samples were withdrawn from various depths and the nitrogen content determined. It is found that aeration is effected by the exposed layer mixing with the unexposed portions of the water to depths of at least 10 feet. This process is caused by the downward "streaming" by the constantly changing layer of water exposed to the air. It proceeds more rapidly, and more uniformly, to depths of at least 10 feet, in salt water than in fresh water. The rate at which "streaming" proceeds depends largely upon the rate at which the concentration and cooling of the surface layer is brought about by evaporation, and proceeds more rapidly at temperatures at and above 10° C. than below it. It is less rapid, and less uniform downwards to 10 feet deep, and probably to greater depths, at temperatures below 8° C., especially in fresh waters. The rate of mixing also depends upon the concentration of salt in solution. The optimum concentration appears to be about 1 per cent. sodium chloride.—T. A. **McLaughlin**: Cataphoresis of air bubbles in various liquids. Air bubbles show no cataphoresis in the following liquids: methyl, ethyl, and butyl alcohols, xylol, benzine, toluene, bromobenzine, benzyl alcohol, benzaldehyde, aniline, cinnamic aldehyde, ethyl malonate, lactic acid, oleic acid, ethyl acetate, and turpentine. It was not possible to trap an air bubble in acetone and volatile liquids such as carbon disulphide. In impure acetone foreign matter moved towards the positive pole. In distilled water, air bubbles moved towards the positive pole; in impure benzine, towards the negative pole; in "pure" nitrobenzine, to the negative pole. In impure nitrobenzine the motion may be to either pole.

PARIS.

Academy of Sciences, April 24.—M. Emile Bertin in the chair.—E. **Goursat**: The theory of integral invariants.—P. **Marchal**: The metamorphosis of the females and hypermetamorphosis of the males in the Coccidia of the Margarodes group. Both males and females pass through three forms—first a primary hexapod larva capable of migration; then a cystoidal larva adapted to life fixed to a plant; and, thirdly, a hexapod form, at which stage the development of the female is arrested. The male continues to develop through two or three other forms before reaching the winged stage.—L. **Lumière**: Capillary movement, diffusion, and displacement. A study of flow through filter paper and cotton strips used as siphons. The flow of liquid increases with the height of fall up to a certain distance and then remains constant. Some practical applications are given, including washing photographic negatives and precipitates with minimum quantities of water. A negative 9 cm. by 12 cm. can be washed completely in 15 minutes with less than 30 c.c. of water.—E. **Vessiot**: Surfaces generated by circles.—E. **Cartan**: The equations of structure of generalised space and the analytical expression of Einstein's tensor.—E. **Nörlund**: The interpolation formula of Newton.—B. **Gambier**: Point correspondence of two surfaces and a class of surfaces analogous with isothermal surfaces.—A. **Pictet** and J. H. **Ross**: The polymerisation of lævoglucosane. Lævoglucosane, heated to 140° C. in the presence of a trace of zinc chloride, polymerises in accordance with the equation $nC_6H_{10}O_5 = (C_6H_{10}O_5)_n$ in a few minutes. Different polymers are obtained by varying the pressure: at 15 mm. of mercury $n=2$ and the product is dilævoglucosane $(C_6H_{10}O_5)_2$, at atmospheric pressure $n=4$, under 4·6 atmospheres $n=6$, and at 13·3 atmospheres $n=8$.—P. **Gaubert**: The liquid crystals of calcium phosphate.—P. L. **Mercanton**: The magnetic state of arctic basalts. Since the Tertiary period the magnetic inclination of the earth in the northern regions would appear to have changed its sense: to complete the proof an examination of antarctic larvas is desirable.—S. **Stefanescu**: The phylogeny of *Elephas antiquus*.—A. **Carpentier**: The conifers and ferns of the Weald of Féron-Glageon.—J. **Maheu**: A retarded regeneration of moss. A detailed description of the growth of a specimen of *Barbula muralis*, after remaining 14 years in a state of absolute dryness.—G. **Nicolas**: Remarks on *Narcissus tazetta*.—G. **Malfitano** and M. **Catoire**: Amylocellulose considered as a compound of silicic acid and amylose. Experimental evidence that silica is an essential constituent of amylocellulose.—A. **Vila**: The influence of heat and of some solvents on the viscosity of horse serum. The coagulating effect of acetone, analogous with that of heating, can be reduced or even avoided altogether by taking certain precautions.—Y. **Manouélian**: Histo-microbiological researches on general paralysis. Existence of the treponeme in the cytoplasm of the nerve cells of the cerebral cortex.

Official Publications Received.

Annual Report of the Academy of Natural Sciences of Philadelphia for the Year ending November 30, 1920. Pp. 57+6 plates. (Philadelphia.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 73, Part 2, 1921. Pp. 193-435+plates 9-47. (Philadelphia.)

State of Connecticut. Public Document No. 47. State Geological and Natural History Survey. Vol. 6, Bulletins 23-32, 1915-1920. (Hartford.)

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Extracted from Year Book No. 20 for the Year 1921.) Pp. 307-357. (Washington.)

Jahrbücher der Zentralanstalt für Meteorologie und Geodynamik. Amtliche Veröffentlichung. Jahrgang 1917. Neue Folge, 54 Band. Pp. xxviii+A24+B38+C41+D22+E6+F18+G38. (Wien: Gerold und Komp.)

Leeds University. Seventeenth Report, 1920-21. Pp. 166. (Leeds.)

Royal Magnetical and Meteorological Observatory at Batavia. Observations made at Secondary Stations in Netherlands East-India. Vol. 8 (1918). Pp. ix+104. (Batavia.)

University College of North Wales. Calendar for Session 1921–22. Pp. 394. (Bangor.)

The Journal of the Royal Agricultural Society of England. Vol. 82. Pp. 8+298+cxxxii+x+28. (London: J. Murray.) 15s.

Review of Agricultural Operations in India, 1920–21. Pp. vi+120. (Calcutta: Government Printing Office.) 1.4 rupees.

Annual Report of the Director, Kodaikanal and Madras Observatories, for 1921. Pp. ii+25. (Madras: Government Press.) 6 annas.

Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Limited, Turner's Hill, Cheshunt, Herts. Seventh Annual Report, 1921. Pp. 52. (Cheshunt: Cheshunt Press, Ltd.)

Department of Agriculture and Natural Resources: Weather Bureau. Annual Report of the Weather Bureau for the Year 1918. Part 4: Hourly Results of the Observations made at the Magnetic Observatory of Antipolo, near Manila, P.I., during the Calendar Year 1918. Pp 47. (Manila: Bureau of Printing.)

Diary of Societies.

FRIDAY, MAY 19.

INSTITUTE OF TRANSPORT (at Institution of Civil Engineers), at 10 A.M.—D. H. Davies: The Finance of the Modern Highway: A Problem and a Solution.—Prof. J. Carlier: Foreign Railway Practice.—Col. J. W. Pringle: Safety in Railway Operation.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—W. Rushton: Further Contributions to the Biology of Freshwater Fishes.—Prof. J. H. Priestley: Toxic Action of Illuminating Gas on Plants (with Demonstration).

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Annual General Meeting.

INSTITUTE OF TRANSPORT (at Royal Society of Arts), at 5.—F. V. Russell: The Operation of Heavy Suburban Passenger Services on a Steam Railway, with particular reference to Density of Service, Terminal and other Facilities.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section) (Annual General Meeting), at 7.—A. H. Reeves: The Elimination of Atmospherics in Radio-telegraphy.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section) (Annual General Meeting) (at Langham Hotel), at 7.15.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—H. Dewey: The Sources and Transport of Non-local Rocks in the London Area.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—F. W. G. Clark: Engineering Business in China.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir William Bragg: The Structure of Organic Crystals.

SATURDAY, MAY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. O. W. Richardson: The Disappearing Gap between the X-ray and Ultra-violet Spectra. II. Photo-electric Methods.

MONDAY, MAY 22.

ROYAL SOCIETY OF MEDICINE (Odontology Section) (Annual General Meeting), at 8.—E. Sprawson: The Significance of the Extra Cusp commonly found on the Antero-internal Aspect of the Maxillary First Permanent Molar in Man.—H. C. Malleson: Some Notes on Dental Histology.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—H. Lee Shuttleworth: The Border Countries of the Punjab Himalaya.

TUESDAY, MAY 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. Bulloch: Tyndall's Biological Researches and the Foundations of Bacteriology (2). (Tyndall Lectures.)

INSTITUTE OF PHYSICS (Annual General Meeting) (at Royal Society), at 5.—Sir J. J. Thomson: Presidential Address.

ROYAL SOCIETY OF MEDICINE (Medicine Section) (Annual General Meeting), at 5.30.—M. P. L. Violle: A Practical and Accurate Method of Estimating Diuresis.—Dr. W. Hunter: The Nervous Disorders of Severe Anæmias in relation to their Infective Lesions and Blood Changes.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions to the Society's Menagerie during the month of April 1922.—Rev. H. N. Hutchinson and E. Godwin: Exhibition of a Plaster Cast of a Model Reconstruction of the Marine Reptile *Peloneustes philarchus*, a Pliosaur from the Oxford Clay.—Sir Sidney F. Harmer: Commerson's Dolphin and other Species of Cephalorhynchus.—C. F. Cooper: Miocene Proboscidia from Baluchistan.—R. I. Pocock: The External Characters of Scarturus and other Jerboas compared with those of Zapus and Pedetes.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—T. Thorne Baker and L. F. Davidson: Spectroscopic Measurements of the Hydrogen Ion Concentration Colour Changes in Recent Indicators.—K. C. D. Hickman: The Dyeing of Silver Iodide with Methylene Blue, including:—(*a*) A Method of measuring Small Quantities of Methylene Blue occluded by Silver Iodide Precipitate; (*b*) The Tanning of Gelatine by Development Action and its Influence on the Process of Dyeing.—E. L. Turner and C. D. Hallam: The Function of the Flash Exposure in Three-colour Work. (Experiments in half tone, 3rd series.)—A. C. Banfield: The Trist Three-colour Exposure Camera.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Dr. B. Malinowski: Theory and Practice of Witchcraft in Eastern New Guinea.

SOCIOLOGICAL SOCIETY (at 65 Belgrave Road, S.W.1), at 8.15.—E. Betham: The National Housing Policy: A Common Sense View.

WEDNESDAY, MAY 24.

LINNEAN SOCIETY OF LONDON, at 3.—Anniversary Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Very Rev. Dr. W. R. Inge: Theocracy (1). Theocracies in General.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.

ROYAL SOCIETY OF ARTS, at 8.—G. Fletcher: The Natural Power Resources of Ireland.

FELLOWSHIP OF MEDICINE (at Royal Society of Medicine), at 5.—Sir St. Clair Thomson: The Surgical Anatomy of the Nose and Accessory Sinuses.

THURSDAY, MAY 25.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Prof. C. H. Lees: The Thermal Stresses in Solid and in Hollow Circular Cylinders concentrically heated.—B. F. J. Schonland: The Scattering of β Particles.—N. K. Adam: The Properties and Molecular Structure of Thin Films. Part II. Condensed Films. Part III. Expanded Films.—E. Wilson: The Susceptibility of Feebly Magnetic Bodies as affected by Compression.—S. F. Grace: Free Motion of a Sphere in a Rotating Liquid parallel to the Axis of Rotation.

INSTITUTION OF MINING AND METALLURGY (Special General Meeting) (at Geological Society), at 5.30.—H. R. Sleeman: The Re-establishment of the Gold-basis of Currency.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Annual General Meeting.

ROYAL MICROSCOPICAL SOCIETY (Metallurgical Section), at 7.30.—L. S. Ward: Notes on Etching and Etching Re-agents.

ILLUMINATING ENGINEERING SOCIETY (Annual Meeting) (at Royal Society of Arts), at 8.—Report of Council;—at 8.30.—Sir John Herbert Parsons: Presidential Address.

ROYAL SOCIETY OF MEDICINE (Urology Section) (Annual General Meeting), at 8.30.—Prof. F. Hobday: Urinary Calculi in Animals.—K. Walker: The Genital System of the Rhinoceros.

FRIDAY, MAY 26.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Thomas W. Arnold: Indian Painting and Muhammadan Culture (Sir George Birdwood Memorial Lecture).

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Dr. F. W. Aston: Atomic Weights and Isotopes (Lecture).

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section) (Annual General Meeting), at 5.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. R. Dudfield: Reforms needed in the Notification of Tuberculosis.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. E. Dalby: The Internal Combustion Engine: Its Influence and its Problems.

SATURDAY, MAY 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Hugh Allen: Early Keyboard Music (1).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

FRIDAY, MAY 19.

LONDON SCHOOL OF ECONOMICS, at 5.—Dr. P. Giles: Modern Views of Indo-European Origins (2).

UNIVERSITY COLLEGE, at 5.15.—A. E. M. van der Meersch: Simplified Solutions for B.M. and S.F. Values for Rolling Loads (2);—at 5.30.—Prof. W. R. Shepherd: The Expansion of European Civilisation (3).

BIRKBECK COLLEGE, at 6.—Dr. E. J. Russell: Recent Work with regard to the Influence of Soil Conditions on Agriculture (2).

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic (4) (Gresham Lectures).

MONDAY, MAY 22.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. F. Widal: Anti-anaphylaxie (in French).

KING'S COLLEGE, at 5.30.—Prof. F. H. Edgeworth: The Development of the Head Muscles of Vertebrates (1).

TUESDAY, MAY 23.

UNIVERSITY COLLEGE, at 5.—Sir Arthur Shipley: Insects and Disease (4).

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Principle and Method of Hegel (4). The Concrete Universal.—Prof. F. H. Edgeworth: The Development of the Head Muscles of Vertebrates (2).

WEDNESDAY, MAY 24.

KING'S COLLEGE, at 4.—Dr. A. Harker: Tertiary Igneous Action in Britain (2).—Prof. F. H. Edgeworth: The Development of the Head Muscles of Vertebrates (3).

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. R. A. Nicholson: The Idea of Personality in Sufism (2).

UNIVERSITY COLLEGE, at 5.15.—Dr. D. H. Scott: The Early History of the Land Flora (5).

THURSDAY, MAY 25.

CHELSEA PHYSIC GARDEN, at 5.—E. A. Bowles: Superstitions of Early Herbalists: particularly the Doctrine of Signatures, illustrated by Living Plants (Chadwick Lecture).

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Prof. E. H. Starling: Some New Experiments on the Kidney.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. H. Vaquez: De l'Érythrémie (Maladie de Vaquez-Osler) (in French).

KING'S COLLEGE, at 5.30.—Prof. F. H. Edgeworth: The Development of the Head Muscles of Vertebrates (4).

UNIVERSITY COLLEGE, at 5.30.—Prof. W. R. Shepherd: The Expansion of European Civilisation (4).

FRIDAY, MAY 26.

BIRKBECK COLLEGE, at 6.—Dr. E. J. Russell: Recent Work with regard to the Influence of Soil Conditions on Agriculture (3).

NATURE

SATURDAY, MAY 27, 1922.

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The Dark Ages: A Survival in Kentucky.

It is probable that Mr. Bateson would not have been surprised to find that some points in his address on "Evolutionary Faith and Modern Doubts," delivered at Toronto before the American Association for the Advancement of Science (see NATURE, April 29), gave rise to a certain amount of criticism and discussion; but we should have thought that neither he nor any one else could have anticipated that this able deliverance would be used as a text on which to found a violent attack upon the teaching of evolution in the schools of a civilised State. Such, however, is the fact; and the attempt to force this remarkable form of prohibition upon the Kentucky Legislature was only defeated, after repeated divisions, by a single vote. That an occurrence of this kind should be possible at the present date may well cause astonishment, and the accounts which have reached us of the discussion which took place in the House of Representatives reveal an amount of ignorance and prejudice on the part of responsible legislators which would be ludicrous if it were not lamentable. One of the promoters of the measure, we are told, who spoke for nearly an hour amidst cheers and applause, made a division between "sheep" and "goats," placing the principal opponents and various zoology text-books in one class, and the Bible, the Declaration of Independence, and himself in the other. He wound up his discourse by throwing one of the text-books on the floor and trampling it underfoot. The gentleman by whose single vote the proposal was eventually negatived "believed that what was would be anyhow," but said that he would have to discard his religion and vote "No." Why his declared belief should necessitate such a renunciation does not seem to have been stated.

It is unfortunately impossible not to take these exhibitions of irrationality seriously. If they concerned merely the proceedings of a debating society they might be passed over with a smile, but what is here involved is the whole scheme of education in an important section of a great community. It is nothing less than a shock to civilised opinion to find that half the members of a State legislature are oblivious of the fact that, in spite of domestic differences as to the methods of evolution, not a single scientific man of any repute doubts the fact of evolution itself. A refusal to recognise evolution as an established principle is equivalent to eliminating from the teaching of the rising generation the whole body of modern science, chemical and physical no less than biological.

A more disastrously retrograde step in education could scarcely be imagined. It is not too much to say that those who would forbid the teaching of evolution

on religious grounds are doing their best to discredit the religion they profess. We cannot believe that sane opinion in any civilised country would regard the success of such a proposal with anything but the strongest disapproval, and would not heartily commend the utterance of one of the Kentucky representatives who said in the course of the discussion, "I am ashamed of this day in the Kentucky Legislature." If the proposal which was defeated by so narrow a margin had been carried, it would have meant that the State of Kentucky chose deliberately to stand aside from the stream of modern progress, and was content in scientific matters to revert to the intellectual conditions of the dark ages. Some excuse may possibly be alleged for the attitude of the authorities of the time towards the discoveries of Galileo, and even for the distrust with which the work of the early geologists and of Darwin himself was generally received. No such palliation can be pleaded to-day, but the astonishing fact remains that Mr. Rudyard Kipling's imaginary "Village that voted that the Earth was Flat" has been all but paralleled by a State of the American Union.

It would be well if this outburst were a solitary instance of the absurdities that may result from placing the decision of important educational questions in the hands of those entirely incompetent to deal with them. But it is unfortunately the case that the same, or a similar spirit of ignorant intolerance has manifested itself in other quarters besides Kentucky. In the State of South Carolina, a provision has passed the Senate, apparently without opposition, to the effect that "no moneys appropriated for public education or for the maintenance and support of state-supported institutions shall be used or paid to any such school or institution teaching, or permitting to be taught, as a creed to be followed, the cult known as 'Darwinism.'" It is true that this provision was ultimately rejected by the action of a joint committee of the House and Senate, but it is said that another attempt will probably be made to pass it on a future occasion. In explanation of the somewhat curious wording of the proposal, it was stated by its promoter that it was intended to apply only to Darwinism, and not to the theories of Lamarck, Bergson, Le Dantec, Baldwin, or Osborn; further, that it only attempted to penalise Darwinism when taught or permitted to be taught "as a creed to be followed."

It is, of course, true that many convinced evolutionists cannot properly be described as Darwinians; but even if Darwinism, defined as the theory of the origin of species by natural selection, were far more generally discredited among evolutionists than is actually the case, there would seem to be no reason for making a special exception in its disfavour, while allowing teachers to inculcate any of the theories of Lamarck, Bergson and the rest "as creeds to be followed." Whatever may be the ultimate fate of the Darwinian theory, which it is not our present purpose to discuss, it will remain in history, as a recent writer has said, "as the working hypothesis which has led to the establishment of the fact of organic evolution." The attempt, on any ground, to exclude the broad doctrine of evolution or an adequate presentation of the Darwinian theory from the education of the young, is a piece of folly comparable only to the futile endeavour of Mrs. Partington with her mop to stay the advance of the Atlantic Ocean.

F. A. D.

Endocrines in Excelsis.

The Glands Regulating Personality: A Study of the Glands of Internal Secretion in Relation to the Types of Human Nature. By Dr. L. Berman. Pp. vi + 300. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1921.) 18*s.* net.

AS we watch the progress of history as unfolded by the daily press we often find it hard to say whether the event just brought under our notice is an affair of John Smith being sold up because he has failed to pay his rates —a merely local matter—or one of a John Hampden being distrained on account of ship-money—an event destined to be wide reaching in its effects. It is so in the progress of science; of this one is forcibly reminded in the chapters of this book, wherein its author, Dr. Louis Berman, traces the rise and progress of our knowledge regarding the action of internal secretions on the growth, health, and behaviour of the animal body. He duly notes that in the eighteenth century Bordeu of Paris explained the effects of castration on a theory of internal secretions, and he might also have recorded the results of John Hunter's experiments in transplanting the genital glands as well as the spurs of cocks and hens. He notes the very decisive experiments made on cocks by Berthold of Göttingen in 1849. He gives Dr. Thomas Addison full credit for showing, in 1856, that disease of the adrenals was followed by definite changes in the human body. Brown-Séquard has full justice done to him; in 1889, at the age of 73, it is related how he put his theory of internal secretions to the test of practice by seeking for rejuvenescence of his body and brain by the help of testicular extracts. By pooling the experience of Gull, Ord, Kocher, Reverdin, Schiff, and Horsley, the late Sir Felix Semon, as our author notes, was able in 1888 to convince medical men that the ductless thyroid gland had a most potent action on the health and appearance of the body.

That the pituitary gland has an influence on the

growth and moulding of the body became apparent after Marie recognised the disorder which he named acromegaly in 1886. Following these events, Dr. Berman duly notes the discoveries relating to the action of substances formed in the adrenal and pituitary glands by Sir E. Sharpey Schafer, described by our author as "Schaefer, the Scotch physiologist, who has done more than any other living man to stimulate study of the internal secretions." Then follows a mere mention, as if it were a mere minor or parochial event, of the discovery announced by Bayliss and Starling in the Proceedings of the Royal Society for 1904, namely, that the pancreas was set into action by a substance which, formed in the mucous membrane of the duodenum, is carried by the circulating blood to the site of its action.

For Dr. Berman the discovery made by Bayliss and Starling was but a parochial affair of John Smith; for the writer of this notice it is the John Hampden episode leading to a revolution which is transforming the whole field of biology. One has only to turn to the Croonian Lecture given by Prof. Starling at the Royal College of Physicians in 1905 to realise that he was under no delusion as to the revolutionary effect of the discovery of the "hormone" which he named "secretin." He realised that the discovery had revealed Nature's most ancient mode of co-ordinating the action of living units; that a new and potent factor had been placed in the hands, not only of physiologists but also of every man or woman who was working at any department or aspect of living matter—one which gave them a working theory to explain myriads of obscure phenomena. It was the merit of Dr. J. T. Cunningham to apply the new theory to heredity and evolution.

The hormone theory as propounded by Starling in 1905 has had an effect on all branches of medicine—in surgery, medicine, obstetrics, and particularly on psychology. For many thousand years, men of nearly all countries have realised that the removal of the genital glands produces a profound change in the nature and behaviour of all kinds of domesticated animals. The ancient Egyptians must have been aware of these effects. It is the intricate and multitudinous action of hormones on the nervous system which has enlisted the particular enthusiasm of Dr. Louis Berman. In this book he has set out in full detail not only all that can be said in sobriety relating to the *rôle* of internal secretions in regulating behaviour and temperament, but also a great deal which may be true but at present is entirely imaginary. It is with no hint of disrespect that the reviewer suggests that, after all, the unnumbered myriads of nerve cells which make up the brain have something to do with behaviour and personality; the qualities of a man or woman are not determined by internal secretions alone.

The thesis maintained by the author is best given in his own words (p. 23):

"The life of every individual, normal or abnormal, his physical appearance, and his psychic traits, are dominated largely by his internal secretions. All normal, as well as abnormal individuals are classifiable according to the internal secretions which rule in their make-up. Individuals, families, nations and races show definite internal secretion traits, which stamp them with the quality of difference. The internal secretion formula of an individual may, in the future, constitute his measurement which will place him accurately in the social system."

In the latter chapters of this work Dr. Berman proceeds to explain, on an endocrine formula, great or uncommon figures in history such as Napoleon, Cæsar, Florence Nightingale, Darwin, Nietzsche, and Oscar Wilde. No doubt there is much to be said for many of his contentions, but when we find Napoleon classed as a "pituitary centred, ante-pituitary superior, post-pituitary inferior, with an instability of both, that would lead to his final degeneration," we have to own that the ordinary historian is not likely to find endocrinology as here presented really helpful to him.

We should not do Dr. Berman and his book justice unless we mentioned the vigour of his style. Every sentence has a "punch" in it—indeed the reader often longs for a plain statement of fact. It is a book which compels one to think as well as to criticise.

A. KEITH.

Positive Rays.

Rays of Positive Electricity and their Application to Chemical Analyses. By Sir J. J. Thomson. (Monographs on Physics.) Second edition. Pp. x + 237 + ix pl. (London: Longmans, Green and Co., 1921.) 16*s.* net.

ALL physicists and chemists, with many who, though less directly, are yet no less deeply interested in the subjects opened up by the study of the phenomena of the discharge tube, will rejoice that Sir J. J. Thomson has found time, amid his many preoccupations, to bring out this second edition of his well-known monograph on rays of positive electricity. The output of scientific work is now so enormous that it is difficult to keep pace with it even in one's own special line of study. It would be practically impossible, if it were not for the assistance given by books such as this, ever to come abreast once more of a subject in which one has once fallen behind. In writing this clear and authoritative account of the

present state of a subject which he has done so much to develop, Sir J. J. Thomson has performed a real service to science.

Although the intervention of the war delayed for some time the fulfilment of the prophecy made by the author in his preface to the first edition, that the method of positive rays would be of service in connection with important chemical problems, it has since been so signally verified that the scientific world has been shaken, and the distant reverberations have re-echoed even through the columns of the daily press. The discovery, made by means of the positive rays, that the chemical elements are in many cases mixtures of substances of almost identical properties but of different atomic weights is, indeed, one which may well justify the distinguished author of the method of positive ray analysis in his conviction "that as yet we are only at the beginning of a harvest of results which will elucidate the process of chemical combination, and thus bridge over the most serious gap which at present exists between physics and chemistry." In addition, however, to advances of which no one could be completely ignorant, many of us were aware that a considerable volume of research of a less startling, but not necessarily less important, character had accumulated in the eight years which have elapsed since the publication of the first edition of "Rays of Positive Electricity," and will welcome this well-balanced account of the present state of the subject as a whole.

The growth of the subject is indicated by the size of the present volume, which is almost twice that of its predecessor. So much has been added to the text and so many sections have been rewritten, that although here and there a critical reader may detect, by some imperfectly concealed join, that a portion of the old text still survives, the book is to all intents and purposes a new production. It cannot be said that the present volume is quite so easy to read as its predecessor. The subject has grown not merely in size, but also in complexity, and all the author's well-known powers of exposition are required, at times, to guide the reader through the very complicated phenomena of the discharge tube. The journey is, however, lightened by the skill with which the author succeeds in visualising the most abstruse physical phenomena, and is illuminated by the frequent flashes in which, rising from the particular to the general, he links the happenings in his discharge tube with some of the outstanding problems of physics and chemistry. Thus new light is thrown, not only on such problems as the disintegration of metals and the production and absorption of gases in the discharge tube itself, but also on the origin of spectra, the mechanism of ionisation, the varieties of chemical combination, and the structure of atoms and molecules.

An interesting account is given of the various methods which have been evolved for producing and measuring the positive rays, including, of course, the mass-spectrograph employed by Dr. Aston for the investigation of isotopes. It is thus possible to compare the relative advantages and limitations of the different methods. The excellent plates at the end of the volume leave little doubt that, when accurate measurements of the masses of the particles are required, the much greater dispersion which the mass-spectrograph makes possible gives it undoubted advantages over other methods. It is, however, not adapted for the investigation of the intricate phenomena of the discharge itself, and it is mainly to the latter problem that Sir J. J. Thomson has devoted his own researches. The reproduction of some of the author's more recent photographs shows the considerable advance which has been made in the technique of the experiments, while new methods of measuring the plates, indicated in the text, add greatly to the accuracy of the measurements.

In addition to the now well-known parabolas, the author directs particular attention to the existence of numerous other secondary lines of very varied appearance and to the remarkable variations in brightness or "beading" seen on many of the parabolas in the photographs. Considerable space is given to the elucidation of these appearances, and from them the author derives, not only many practical hints for eliminating some of the ambiguities which previously existed as to the nature of the particles to which a given line on the plate must be ascribed, but also much interesting and valuable information as to the processes going on in the discharge tube itself and the mechanism by which the positive rays are produced. It is impossible to pursue the argument in a review, but it forms by no means the least interesting part of the work.

In one respect we fear that the author may unintentionally be misleading his readers, and that is in the statement that the technique of the subject is not difficult. Here we feel that Sir J. J. Thomson is, unconsciously, undervaluing the very exceptional experimental skill which he and his able assistants have shown in this prolonged and difficult series of researches. In particular the electrical method of measuring the rays, which alone seems capable of giving those metrical results which are so desirable for the solution of many of the outstanding problems, has not until the last few months found any successful exponent since the original experiments of the author himself. We can, however, cordially agree that any

chemist with the necessary scientific insight, who would take the time and pains required to become master of the method, would find in it a weapon of research of no mean value.

Some misprints, one or two of which may at first sight rather puzzle the reader, occur. The collection of the whole of the plates at the end of the volume is a great convenience, as the same plate is frequently referred to in different parts of the text. One suggestion we should like to offer in this connection, and that is that the author should provide some key to these very beautiful reproductions of his photographs. It is sometimes extremely difficult for one not versed in the art of reading positive ray photographs to pick out the particular lines referred to in the text from the considerable number which often appear on the corresponding plate. We hope that Sir J. J. Thomson may be prevailed upon to make this concession to human weakness when, at some date which cannot be very far distant, he makes a further revision of the book for its next edition.

J. A. C.

Metamorphoses of Insects.

Insect Transformation. By Prof. G. H. Carpenter. Pp. xi + 282 + 4 plates. (London: Methuen and Co., Ltd., 1921.) 12*s.* 6*d.* net.

METAMORPHOSIS in the animal kingdom may be approached from two angles of vision. We may regard it solely as a preparation for the adult condition that follows upon it, or we may consider it from the point of view of recapitulation of racial ancestry. In reality it is the result of the working of both those factors. Among insects, the higher one ascends among the orders of that class, the more the evidence of recapitulation becomes obscured by secondary changes. Divergence in evolution has occurred between the preparatory and final stages of life. The more highly specialised the perfect insects become the more their larvæ degenerate. It is the inert, legless, eyeless, and often headless maggot that gives rise to the highest expression of insect life. The active "intelligent" type of larva, endowed with limbs and well-developed organs of special sense, is destined to produce an imago lower in the scale of evolution than that which arises from the degenerate larva previously mentioned.

In the springtails there is no metamorphosis. In the locust and the plant-bug metamorphosis is clearly evident, although the young are not very different from their parents. Such insects pass through no pupal stage, and their wings are formed externally. In the majority of insects, however, whether they be beetles, butterflies, bees, or flies, the young or larvæ are vastly different from their parents and a pupal stage has become intercalated in the ontogeny. In insects of this kind the wings arise as impushed imaginal buds and reveal themselves outwardly only when the pupal stage is assumed.

In Prof. Carpenter's book we have a lucid account of the various aspects of the above phenomena. It is elementary, but not unduly so, and there are few biologists who will not benefit by assimilating its contents. The author devotes about two dozen pages to describing the essential features of the morphology of an adult insect. These pages contain nothing that is new to the entomologist, but they enable the more general reader to obtain a better understanding of the book as a whole. The following chapter is devoted to the discussion of the metamorphoses of insects with the open type of wing-growth. This is succeeded by a detailed treatment of the higher orders of insects the wings of which develop from concealed imaginal buds. The remaining chapters treat of wingless insects, the significance of metamorphosis in classification, the surroundings of developing insects, and the various problems of metamorphosis.

The author has marshalled his facts into a continuous whole with conspicuous success. He leads the reader, step by step, through the increasing complexities of metamorphosis in what we believe to be their true evolutionary sequence. He attempts no new theories nor does he throw fresh light on existing theories. He prefers to draw extensively upon the results of recent research and show them in their true perspective. The book consequently represents very completely the present-day point of view. The discussion of larval and nymphal stages naturally occupies a large part of a work of this nature. Prof. Carpenter evidently does not concur with Comstock in his use of the term nymph, and rather adopts the definition that applies it to all exopterygote insects when the latter are in a stage in which the wing rudiments can be distinguished clearly by the naked eye. The expression nymph, however, is a conventional one, and in reality all nymphs are, in the zoological sense, larvae.

The book is one which imparts a true appreciation of how the details of the life-histories of different types throw light on the development of insects as a class. It is well printed and adequately illustrated with figures largely borrowed from the writings of contemporaries, or from Prof. Carpenter's own publications. Few scientific works have been issued since the war at so reasonable a price, which is a matter for congratulation to the author and publishers alike.

A. D. IMMS.

Chemical Disinfection and Sterilisation.

Chemical Disinfection and Sterilisation. By Dr. Samuel Rideal and Dr. Eric K. Rideal. Pp. vii+313. (London: Edward Arnold and Co., 1921.) 21*s.* net.

IN the year 1909 the third and last edition of "Disinfection and the Preservation of Food" was issued. It was a well-known and valuable work written by Dr. S. Rideal, and the many who consulted it will be struck, after perusing the volume under review, with the similarity between the two publications. The new title "Chemical Disinfection and Sterilisation" is a little misleading—for the methods of disinfection described are not always chemical, and the authors have much to say upon the subject of antiseptics, which is neither "disinfection" nor "sterilisation."

There is no one in this country better qualified to treat of the general subject of disinfection than Dr. S. Rideal, so those who consult this book for information on the science and art of disinfection may do so with confidence. But often there will be felt some regret that the information is not more detailed, although the following extract from the preface disarms criticism under this head. "Some apology is needed for the method of presentation. Although some of the problems which are briefly discussed are already dealt with *in extenso* in a wide and varied literature, others, equally important in their respective fields, are scarcely mentioned in current text-books, and it was felt that the inclusion of even a brief summary between the covers of one volume would appeal to those whose interests cover this wide field, but who have neither access to, nor leisure to study, the very scattered literature on the subject." A valuable feature of the work is the bibliographical information at the end of each chapter, supplemented by many useful footnotes.

Chapter 1 is introductory and contains some interesting historical references. Here the statement that "cats and dogs have been shown to carry Diphtheria" is open to challenge. Chapter 2 deals with the disinfection of air; the reference here to the employment of formic aldehyde vapour is particularly good. In chapter 3 the sterilisation and preservation of food is discussed. The inclusion here of the subject of metallic contamination seems inappropriate; and the poisonous products of decomposition, the chemical preservatives employed, and the pasteurisation of milk are far too lightly touched upon. Chapter 4, upon the sterilisation of water, is perhaps the best and most helpful chapter in the book and the authors are to be congratulated upon an excellent and up-to-date statement. Chapter 5 deals with public disinfection. The field is comprehensively surveyed, but the survey is not detailed enough in many parts. For example, the dozen lines devoted to the practical disinfection of excreta are inadequate for the purpose of dealing with this important and difficult subject. Chapter 6, dealing with personal and internal disinfection, contains much useful information. The reference to disinfectant soaps is very full—fuller perhaps than their value, as disinfectants, under the usual circumstances of their employment, would seem to justify.

Chapter 7, upon non-bacterial parasites (lice, scabies, ringworm, fleas, etc.), is full of useful information. The parasites of the lower animals are also dealt with in this chapter. In chapter 8 the complex and difficult subject of the preservation of wood is appropriately treated, while chapters 9 to 13 deal with the chemicals employed in disinfection. The relationship between chemical and physical constitution and germicidal activity is briefly but clearly treated. Chapter 14 deals with methods of analysis and testing; and the Rideal-Walker evaluation test is of course very fully considered, for it is a method which has become widely adopted.

One sympathises with the decision of the authors to make no special reference to those disinfectants which are proprietary articles, and yet the statement seems incomplete when they are excluded, seeing that some of the best liquid disinfecting agents in practical use come into that category.

Full indices of subjects and authors close a book which, despite certain defects (always of omission), is a useful and authoritative statement upon the subject with which it deals.

Electrical Diagnosis.

The Diagnosing of Troubles in Electrical Machines. By Prof. M. Walker. (Longmans' Electrical Engineering Series.) Pp. xii+450. (London: Longmans, Green and Co., 1921.) 32*s.* net.

WHEN an electrical machine is not working satisfactorily it is necessary for the engineer to diagnose the trouble and, if possible, suggest a remedy. The engineer in the works when testing the finished machine has every scientific instrument at his command. On the other hand the engineer responsible for running machinery has only a few voltmeters, ammeters and wattmeters available. Both engineers, however, will probably find what they require in the book under notice. It would be impossible within the limits of a single book to deal with every case that might arise, but there are several general methods of procedure given by the author which if

followed will so limit the position or nature of the fault that its detection becomes easy. Prof. Miles Walker has had exceptional experience with machinery during the last thirty years and so lays the greatest stress on those faults which occur most often; in some cases the faults are due to abstruse causes which make great demands on the expert's knowledge of physical science.

The subjects are well divided, chapters being devoted to break-down of insulation, over-heating, low efficiency, sparking at the brushes, etc. The method of determining the efficiency of an electric generator by air calorimetry—a method first devised and put into practice by Sir Richard Threlfall—is commended and the various methods of measuring the velocity of the stream of cooling air are described. The author attributes to Kennelly the discovery that the heat convection from a thin wire increases as the square root of the air velocity. It is true that Kennelly discovered this law experimentally, but the complete law had been deduced mathematically from physical principles several years previously by the French mathematician Boussinesq. He also proved theoretically Newton's law of cooling; namely, that the heat convected is proportional to the difference of temperature between the wire and the cooling fluid. This law, generally assumed as obvious by engineers, has been verified in the most satisfactory way by physicists.

In chapter 5 the practical application of vector diagrams is described, but the author does not distinguish clearly between the various kinds of vectors which are in everyday use. He begins by considering the vectors of two alternating functions which do not follow the harmonic law. The cosine of the angle between the two vectors is defined as the ratio of the mean value of their product to the product of the effective or root-mean-square value of each. It is therefore a highly complicated function. It can be shown that in accordance with this definition, when we have three alternating functions, their vectors can be represented by three lines drawn from a point in space. Hence, contrary to what the author says, a knowledge of the angles between the first and third and the second and third vectors does not enable us to give the angle between the first and second. The author then proceeds to describe rotating vectors, but he does not state explicitly that he is now making sine curve assumptions. The diagram representing as vectors the fluctuating part of the electrical power taken from the various mains requires more explanation.

The comments made on balanced loads are of interest, but are not very practical. It seems to the writer that a polyphase load is only balanced when the magnitudes of the volt-amperes taken from each main and the phase differences between the volts and amperes of each main are the same.

In a few cases where the author gives formulæ, as, for instance, the formulæ for eddy current losses, it would be a help to many if the proof were indicated. The limitations also of the formulæ should have been stated. A few new words are introduced. The phrase "wattful load" is used to indicate the power expended on the load. It is complementary to "wattless load," a phrase used almost universally by engineers to denote the magnetising power required by the load. Although many diagrams are given showing ripples in waves, harmonic analysis is barely mentioned. The causes of these ripples, however, are described, and many ingenious remedies are suggested.

The Inner Impulse.

La Forme et le Mouvement: essai de dynamique de la vie. By Georges Bohn. (*Bibliothèque de Culture générale.*) Pp. xii+175. (Paris: Ernst Flammarion, 1921.) 4 fr. 50 net.

THE title leads one to expect a discussion of the effect of movement on the form of animals, perhaps new evidence for Lamarck. Nothing could be further from the author's intention. He seeks to show that the laws regulating the reproduction and growth of living creatures are the same as those which govern their movements, and that these are the laws of chemical physics. The conception of an organism as a whirlpool is at least as old as Cuvier, but remained little more than a useful analogy till F. Houssay superimposed on it the idea of vibration. But for him both the vortex and its vibrations expressed the effect on the creature of its environment. Prof. Bohn starts with molecules of living substance, the inherent vibrations of which produce a system not merely vortical but polarised, manifesting its internal forces through oscillations in space and in time. That sentence, so far as possible in Prof. Bohn's own words, will scarcely be intelligible to one who has not read the book. Nor, we are warned, will perusal of the book profit an inquirer unacquainted with the fundamental ideas of physics and mechanics. It may therefore be due to some gap in our knowledge that we rise from a second reading provoked but puzzled, interested but unconvinced.

It needs no very close acquaintance with modern biological research to realise the importance of chemical constitution. We have learned that every species has a chemical character of its own; we are familiar with the part that catalysers, hormones, and other more hypothetical substances, play or are supposed to play in all the functions of the body, in growth, and in the hereditary transmission of form. The study of

tropisms and other movements of living beings has revealed how greatly these depend on purely physical forces. A mechanistic theory of life may not be correct, but is at least intelligible. Prof. Bohn, however, goes much further than this. He would explain the manifold variety of living form, past, present and future, by physico-chemical processes within the creature, influenced from outside only by corresponding chemical or physical factors acting directly. For selection or adaptation he has no use, holding a structure to be a consequence as inevitable as any precipitate in a laboratory test-tube.

Let us illustrate by two of Prof. Bohn's inferences. Stockard has shown that, in sea-water containing an excess of magnesium chloride, the eggs of the fish Fundulus develop cyclopic young to the extent of 50 per cent. These young are as vigorous as the controls, and swim with equal facility. "This fact shows that the evolution of the eye is effected not only, as the Lamarckians believe, under the influence of light, but that it may depend on a chemical factor." Similarly, the fact that various salts, or excess or deficiency of oxygen, favour or inhibit the growth of wings, leads Prof. Bohn to conclude that the insect fauna of oceanic islands must owe its wingless condition to some chemical agent. Wingless insects cannot well have migrated to, say, Kerguelen, but blind cave animals have, in Prof. Bohn's view, sought the seclusion which a cavern grants because they were already blinded.

Failure to follow such tenuous argument need not preclude a welcome to this little book for its insistence on facts and ideas that should certainly prove fruitful, if not on the precise lines imagined by its author. His conclusions seem to ignore that aspect of the unity of nature which is revealed in the myriad interrelations of living things, the delicate balance of life, and the intimate adjustment of successive generations to the changing surface of the Earth. If Prof. Bohn would lock his laboratory door and spend a year in the open field, he might there be exposed to some influences, which, though not purely chemical or physical, would change his mental attitude.

Economic Aspects of Human Wastage.

Waste in Industry. By the Committee on Elimination of Waste in Industry of the Federated American Engineering Societies. Pp. xii+409. (New York and London: McGraw-Hill Book Co., Ltd., 1921.) 20*s.* net.

BRIEFLY to review this book is an almost impossible task, and the only way to accomplish it at all, while doing justice both to the writers and the public, is to give an indication of its contents and the methods employed, at the same time pointing out the fundamental importance of certain of the problems discussed.

The book is the report of a committee which made a detailed inquiry into certain industries with a view of finding out how waste of human effort occurred, and, so far as possible, to appraise the responsibility for such waste. The first part is a summary of the detailed reports, and may be taken as the general conclusions at which the committee arrived. The second part contains the detailed reports of the investigations into the building, clothing, boot and shoe, printing, metal, and textile trades. The third part contains general reports on such specific problems as unemployment, labour troubles, accidents, industrial hygiene, etc. This arrangement of the matter makes it extremely easy for the reader in search of special information to find what he needs with the least possible trouble. An attempt is made to determine the amount of waste due to inefficient management, want of planning, labour turnover, seasonal fluctuations, accidents, etc., and it is clear that a large proportion of the responsibility is due to management. This is necessarily the case, since any improvement reducing wastage from such causes as labour turnover and accidents must at least be initiated by those who are responsible for the general policy of industry.

A criticism that may be passed upon this work is that its outlook is narrow, for, with the exception of a few sections by medical men, attention is confined almost entirely to the economic aspect of human wastage. This is not really a serious criticism. A new science is growing up in all civilised countries which seeks to investigate the interaction between industrialism and human nature. To this infant science psychologists, physiologists, doctors, statisticians, and engineers are all contributing, and we must not blame any specific piece of work if one particular aspect of the question is somewhat over-emphasised. The very existence of such a science is a confession that these problems can no longer be regarded as the preserves of philanthropy or politics, which have both failed to remove any but the crudest abuses, while many of their endeavours to improve matters have done harm because they have been undertaken without knowledge of the scientific factors involved. For example, unemployment has too often been regarded merely as a problem of insurance, and various schemes have been worked out based upon the arguing power of the parties concerned rather than upon scientifically ascertained facts. Unemployment, as is pointed out in this book, has far wider ramifications, and cannot be treated from one point of view alone. However unemployment occurs, it involves a great national and

international waste, and any system which is concerned primarily with alleviating the suffering entailed rather than removing its cause must be inadequate. By proper planning of work so as to meet seasonal fluctuations, by a wiser use of the competitive system and certain methods of standardisation, much can be done to remove a social evil which is probably doing more to destroy the vital energy of the industrial population than any other one cause.

The book contains a great deal of carefully arranged statistical matter which provides useful data for those wishing to study certain problems independently. Many of the recommendations made are naturally more applicable to American conditions than to British, and it is to be hoped one outcome of the publication of this book will be that a similar inquiry will be undertaken in this country.

Our Bookshelf.

A Text-Book of Inorganic Chemistry. By Prof. A. F. Holleman. Issued in English in co-operation with H. C. Cooper. Sixth English edition, revised. Pp. viii + 528 + 1 plate. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 19*s.* net.

Prof. Holleman's text-book is well known as one of the best introductory treatises on the subject, and it is only necessary to point out that the new edition has been revised and brought up to date. In this operation a few minor inaccuracies have escaped notice. Thus, on p. 133 it is stated that of the nine oxy-acids of sulphur (one is omitted), only sulphuric acid has been obtained in a pure state, whereas on p. 146 the two persulphuric acids are described as crystallising in the pure state. The descriptions of preparations are sometimes so condensed as to be almost inaccurate, *e.g.* (p. 54) hydrogen peroxide "in a very concentrated state can be obtained by direct distillation *in vacuo* of a mixture of sodium peroxide and sulphuric acid," and on p. 69, in connection with the preparation of hydrobromic acid, the usual method is scarcely adequately described as "the decomposition of a bromine compound with a hydrogen compound, phosphorus pentabromide and water being employed." The statement (p. 29) that "the atomic weights of most elements are determined from the composition of their oxygen compounds," although common, is quite incorrect, and should be compared with the true state of affairs, given on p. 306.

Typical Flies: A Photographic Atlas. By E. K. Pearce. Second series. Pp. xiv + 38. (Cambridge: At the University Press, 1921.) 15*s.* net.

The atlas of photographic illustrations of typical British Diptera under notice is supplementary to the one published by the author in 1915. It consists of a series of well-executed half-tone figures arranged on 36 pages. The difficulties experienced in photographing such objects as flies really effectually are considerable. In photographing on the enlarged scale required, no amount of "stopping down" will produce an image sharp all over, since all the parts of an insect do not lie in the same plane. Many of the figures are excellent examples of what can be executed by this method. On the other hand, those of the larvæ and pupæ are not very successful: Fig. 16 of the larvæ of Coretha, for example, is far inferior to a good line drawing. It is difficult, however, to understand why some of the specimens used for illustration were not better chosen. Why, for example, figure a Trypetid fly the abdomen of which is so distorted as to appear to be missing; or, in other cases, utilise specimens in which the legs have never been displayed in the process of setting. We gather the object of this work is to stimulate the study of this neglected but highly important order of insects and, by means of suitable illustrations, to guide the beginner in relegating his specimens to their respective families. In the latter respect this atlas will probably prove of distinct service.

The Yearbook of the Universities of the Empire, 1922. Edited by W. H. Dawson and published for the Universities Bureau of the British Empire. Pp. xv + 653. (London: G. Bell and Sons, Ltd., 1922.) 7*s.* 6*d.* net.

The changes which have been made in this valuable handbook since last year's issue was published are due mainly to an increase in scope and therefore in size. Nearly two hundred pages of useful information have been added, in spite of the fact that the price has been reduced to one-half. Brief accounts are given of the universities, together with lists of their staffs, of England, Wales, Scotland, and Ireland, followed by similar statements for the universities of Canada, Australia, New Zealand, South Africa, India, Malta, and Hong-Kong, in the order given. The appendices, which formed a valuable feature of previous editions, have been extended, so that now most of the learned and professional institutions are dealt with. There are also brief notes on continental universities and universities in the United States of America, as well as information on the subjects of inter-university scholarships and grants for research both at home and abroad. The text is reduced to a minimum, but the essential facts are given, and it is difficult to find any other single volume which will serve so effectively as a reference book on institutions for higher education in the British Empire.

Mémoires sur l'Électromagnétisme et l'Électrodynamique. Par André-Marie Ampère. (Les Maîtres de la Pensée Scientifique: Collection de Mémoires et Ouvrages. Publiée par les soins de Maurice Solovine.) Pp. xiv + 111. (Paris: Gauthier-Villars et Cie, 1921.) 3 francs net.

The two memoirs given in this volume have been taken from Ampère's wonderful "Recueil d'observations électrodynamiques," published in 1822. Œrsted had described a few years previously the action of an electric current on a compass needle, and in the first memoir under notice, the mutual action of two electric currents on one another is described. The author then describes the apparatus he made and the

experiments he carried out. Finally he formulates the laws which we use to-day. In the second memoir the formula for the mutual action between two infinitely small elements of conductors carrying currents is proved. Ampère's researches paved the way for much of Faraday's work, and Clerk Maxwell makes full use of his results in his treatise. Clerk Maxwell well called Ampère the Newton of Electricity. The guiding experiments and the theory seemed to start fully equipped from his brain just as Pallas Athene was born fully armed from the head of Zeus.

Small Talk at Wreyland. By Cecil Torr. Second series. Pp. vi+120. (Cambridge: At the University Press, 1921.) 9*s.* net.

IN his second series of "small talk," Mr. Torr, proceeding on the lines followed in his first volume, has brought together a number of pleasantly written discursive jottings on various matters drawn from his own recollections and from the letters and diaries of his father and grandparents. An antiquarian and a scholar, he writes with a light and pleasant touch on such matters as local lore and history, as well as of events in the larger world. The value of these notes lies in the light they throw on the social habits and customs of the middle of the last century; they deal with those illuminating details which are apt to evade the more formal historian. Interspersed are observations of and reflections on happenings which have befallen Mr. Torr during his travels in the Mediterranean and in Palestine. All topics, whether of a serious or a lighter character, are touched upon in a manner which can only be described as urbane. On one subject alone does Mr. Torr's urbanity desert him, and that is when he is moved to comment upon the Government regulations for the cultivation of the land during the war.

Chemical Reactions and their Equations: A Guide and Reference Book for Students of Chemistry. By Prof. I. W. D. Hackh. Pp. viii+138. (Philadelphia: P. Blakiston's Son and Co., 1921.) 1.75 dollars.

"THE inability to balance a chemical equation is a most common difficulty to students of chemistry." The author has attempted to remedy this very common weakness, and in addition to a concise explanation of chemical notation, including difficult cases of oxidation and reduction and ionic reactions, has provided a list of more than four hundred classified and indexed chemical equations. The book should prove a useful companion to degree students. In the list of solubilities "to be memorised" one finds: "BORATES are SOLUBLE," which is not strictly correct, since most borates are insoluble.

The Practical Chemistry of Coal and its Products. By A. E. Findley and R. Wigginton. Pp. 144. (London: Benn Bros., Ltd., 1921.) 12*s.* 6*d.*

THE analysis of coal, coke, ammonia liquor and ammonium sulphate, tar and its distillation products, gas (including calorimetry), pyrometry, and water analysis, are the topics dealt with in this book. The volume is very attractively printed and illustrated and should prove most useful in works laboratories.

Letters to the Editor.

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Definition, Resolving Power, and Accuracy.

IN scientific writings the term "definition" most often refers to the clearness with which details are shown by optical instruments; but by a convenient generalisation it might be taken to mean the ratio of the greatest to the least quantity which any kind of apparatus can render apparent at the same time, being thus distinguished from "sensitiveness" or "resolving power," which is determined simply by the smallest quantity measurable without reference to the size of the field.

In this sense the question of "definition" enters into every kind of measurement. In telescopes and microscopes, for example, it would denote the angular or linear size of the field of view compared with the smallest corresponding quantity which can be clearly distinguished; or, in a balance, the greatest arc through which it can swing compared to the least angle of swing giving a trustworthy measure of change of weight.

Since all measurements have in the end to be recorded by the senses either of sight, hearing, or touch (smell and taste have not yet been examined quantitatively), it is of interest to inquire what kind of definition can be expected in their case, and the following notes contain some of the results of various observations on the subject made at intervals during many years.

Sight and hearing are both dependent on wave-motion, and the sensations produced vary with the intensity, frequency, direction, and duration of the waves. The total range of sensible intensities is enormous; for it is seldom that a night is so dark, or a silence so complete, that absolutely nothing can be seen or heard, yet the eye can work without injury in bright sunlight, and the ear can hear with such noises as thunder or great explosions. In these cases the ratio of the greatest to the least appreciable intensity must be of the order of millions.

Although, however, the perceptions of intensities have such wide limits, the differences which can be recognised at any one time or in any constant conditions are much more limited.

In many respects the senses may be compared with a musical instrument which, while of restricted compass, can be tuned to almost any absolute pitch, so that though for any one tuning comparatively few notes can be sounded, yet by adjustment these notes may take any desired position in the audible scale. Each sense, in fact, seems to adjust itself to some kind of level suitable to its surroundings, and to be able (so far as my own observations go) to discern differences of from 5 to ½ per cent. of the range then appreciable.

The same order of definition was found not only for each sense but also for the co-ordination of the senses with muscular action.

The following experiment on the greatest difference between the intensities of light which can be perceived at the same time always gave fairly consistent results. A long tube AB, Fig. 1, about two inches in diameter, and well blackened inside, was provided with a white paper flange at A, and a movable piston, C, also covered with white paper. A disc of white paper, D, of rather less diameter than the tube was placed at

a short distance from the flange, and could be illuminated by sunlight or other means. A small hole in the disc allowed the eye to look in the direction of the axis of the tube, and when the piston was

FIG. 1.

flush with the flange the view obtained was of a uniformly white surface lit by the light scattered from D.

The experiment consisted in withdrawing the piston until it became invisible, the relative intensities of the illumination of the flange or piston face then being DC^2/DA^2. For sunlight the ratio was about 220 to 230 and for candle-light about 170, thus indicating a definition 0·45 and 0·5 in each case.

Analogous experiments were tried on sound by the use of two lever clocks placed at some distance apart. The distance was then noted at which the ear had to be placed from each in order that one set of "ticks" might be drowned by the other. Musical sounds of the same pitch and loudness were tried in the same way. It is always difficult to make in-door experiments on sound on account of the echoes from walls and furniture, but on the whole it appears that the definition for the intensity of sound was not so good, though of the same order, as for light.

As regards the definition for wave-length, that is, the recognition of colour and pitch, the range for visible light waves is much narrower than that for sound. The lengths of all the visible rays lie within the ratio of two to one, while in sound a compass of more than ten octaves is audible. Few people when viewing the whole spectrum at once will distinguish more than seven or perhaps eight colours, but when only a small portion covers the visible field, the variations of tint are much more marked. I have been told by one well-known observer that he could distinguish between the yellows a very short distance on either side of the D lines. This would correspond to a difference of wave-length of five or six parts in a thousand, but since wave-lengths at the orange and green end of the yellow do not differ by more than a hundred parts in a thousand, the definition implied is not better than five per cent.

Few ears are so unmusical as not to be able to distinguish intervals of a semitone (wave-length ratio about ten per cent.), but fewer still can at once distinguish between a major and minor semitone (about one per cent.), and even fewer between the true semitones and their equal temperament substitute.

The sensibility of the ear to change of pitch varies largely in different parts of the audible range, and is at its best in the two octaves above and the octave below the middle C.

In both light and sound the judgment is improved if there is a fixed standard for reference. No standard would be required by the normal eye to determine whether an object was red, yellow, or blue, but doubt might easily be felt as to the exact shade of the colour if the objects were seen separately at considerable intervals of time, and the longer the interval the less as a rule is the judgment to be trusted.

The relation of musical notes sounded in succession in the same way is less correctly estimated when the time intervals between them are long than when they are short, except for those who have the sense of absolute pitch. I have no good data as to the range over which this rather rare sense extends, but have reason to believe that in some cases and in the vocal compass it is accurate to within one per cent.

The same sort of memory which enables a definite colour or pitch to be recognised without any external standard of comparison is requisite also for the mental division of intervals of space or time. I have known people who could mark off inches and count seconds by memory with errors of not much more than one per cent., but they could not deal with feet or minutes with anything like the same accuracy.

In estimating fractions of a second a good transit observer will approach a two per cent. standard, but whether the second is the best time interval for mental division may be questioned.

As regards the division of space by estimation I may mention the following simple experiment which I have often repeated at intervals of years and always with the same result.

On a sheet of ruled foolscap draw two straight lines intersecting near one end of the sheet, and about six inches apart at the other (Fig. 2). Mark the inter-

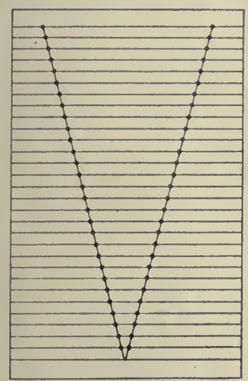

FIG. 2.

sections of these lines with the ruling by well-defined circular black spots, and from another sheet cut out a slot about six and a half inches long and half an inch wide. This when superposed on the first will allow one pair of spots to be visible at the same time. Now, always keeping the eye at the same distance from the paper, mark in succession the point estimated to be midway between each pair. These marks should all lie on the bisector of the angle between the first drawn divergent lines.

In all my trials I found that so long as the subtense of the pair of spots was small enough to allow of both being seen clearly at the same time, the angular error in the estimation of the bisection was more or less constant and ranged from 1/500 to 1/1000 (*i.e.* from $\frac{1}{50}$ to $\frac{1}{100}$ inch at ten inches, the distance of the eye from the paper). The error, however, increased rapidly when the spots were so far apart that they had to be viewed in succession. This occurred when their subtense was about 20°, and the best bisections were made with a subtense of 15° to 12°.

For smaller angles the definition was not so good, for though the linear error on the paper did not change much, it had to be compared with the smaller distance between the spots. In my own case, for angles greater than 20° the error in the bisection was always to the left, but this probably is a personal matter.

As for space, so for time, there must be some particular interval which is best suited for division of estimation, and my impression is that this is somewhat, but not much, longer than a second. As an example of the importance of the correct estimation

of the bisection of a space, I may refer to the results of the recent eclipse expedition which were supposed to confirm Einstein's theory regarding the effect of gravity on light.

According to the account given in the Report (Phil. Trans. A, vol. 220) only one of the sets of eclipse photographs was quite satisfactory, and this was taken by a 4-inch object glass having a focal length of 19 ft. At this distance one-thousandth of an inch would subtend one second of arc nearly, and a 4-inch lens would be just sufficient to separate objects this distance apart. Thus if the lens and photographic plate were perfect, the image of a star would be represented by a circular spot 0·001 in diameter surrounded by one or perhaps two faint rings. In the actual negatives, from irradiation and other causes, the star images were easily visible to the naked eye, and were (speaking from inspection only) about a hundredth of an inch across.

The object of the photograph was to determine the position of the stars to within a small fraction of 1″, so that 10 per cent. in the estimate of the bisection of the 0·01 inch image would represent an angular error several times as great as the whole deviation of the ray suggested by the theory.

The image of a star on a gelatine plate is not a sharply defined disc, but a group of dots crowded together towards the centre but more sparsely scattered round the circumference. This is illustrated by Fig. 3, which is the enlargement (×300) of the

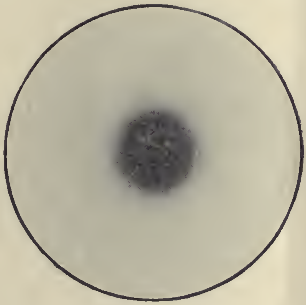

FIG. 3.

direct contact print on a slow "Imperial" plate of a hole 0·0015 in diameter pierced through thin copper foil, and is therefore probably rather more sharply defined than an image formed by a lens.

Thus the evidence for Einstein's theory (so far as the eclipse results are concerned) turns on the question of how much closer than ten per cent. can the bisection of such an area as the figure shows be estimated by the eye.

What magnification was used in the measuring apparatus is not stated in the Report, but assuming that it was between 20 and 40, Fig. 3 would have to be held between 25 and 50 inches from the eye in order that it should appear of the same size as the star image would in the measuring microscope.

Another matter of some interest is the acuteness with which the senses perceive vertical or horizontal acceleration, or in other words the variation of the intensity and direction of the forces acting on the body.

In the inquiry into the vibrations caused by trains in the London Tube Railways, it was found that residents in the neighbourhood began to complain when the vertical movements at the rate of 15 per second amounted to so little as one-thousandth of an inch (amplitude 0·0005), corresponding to a maximum acceleration of $g/12$, but that much smaller accelerations could be felt. Up to a frequency of 40 per sec. or thereabouts, the quicker the vibration the smaller was the amplitude which was perceptible. With frequencies sufficient to give rise to an audible note, the character of the sensation gradually changed.

Church towers rock when the bells are rung, and on one tower rather celebrated in this respect I measured the maximum horizontal amplitude of $\frac{1}{12}$ of an inch, the frequency being rather less than 3 per second. The maximum acceleration in this case also was about $g/12$ and produced feelings of sea-sickness in many people. Accelerations of less than a tenth of this amount, however, were quite noticeable.

I have no notes on the effects of vibrations of long period, but I should expect that any periodic motion which involved an acceleration of $g/200$ would not pass unnoticed, if the conditions were favourable and the attention directed to the subject.

The following are a few examples of the accuracy with which the senses can direct muscular action. In match-rifle shooting sequences of 100 bulls'-eyes (24 inches) at 1000 yards are not unknown. In this case the symmetry of the sight and the target are an assistance in aiming, and since part at any rate of the deviations of the shots are due to wind, etc., the actual alignment of the sights cannot be much greater than 1 in 4000.

By the assistance of a champion billiard player I found that, in playing at a ball under the cushion from balk, he seldom missed the centre aimed at by more than $\frac{1}{8}$ inch. This is equivalent to an accuracy of 1 in 1000. The trials were made by using a paper disc, backed with carbon-tissue and a hard wood support, as the target, the disc being of the same diameter as a billiard ball. The point of impact was shown by the black dot left by the carbon on the reverse side.

A good bowler can generally hit a single stump at 22 yards. A cricket ball has, I believe, a diameter of $2\frac{5}{8}$ inches, so that taking the thickness of the stump into account the accuracy in this case is about 1 in 380.

As regards archery, the best of modern archers[1] will scarcely keep his arrows within a 3-ft. circle at 100 yards. If he did the accuracy would be 1 in 200.

For a game-shot who can bring down 75 per cent. of his birds at 40 yards, the implied accuracy of aim is about 1 in 70.

In all these cases the attention is concentrated on a field of only a few degrees, and the effect of the restriction of the field on the accuracy of the estimation of the position of objects within it is worthy of more investigation than it has yet received.

In judging the qualities of the instrument with which measures are made, a distinction should be drawn between accuracy or resolving power and definition. The accuracy with which a weight can be determined by a balance, or a resistance by a Wheatstone bridge, is greater than one part in a million, but the definition is, for the balance, the length of the arc in which it can swing compared to the least angular motion which gives a trustworthy indication, and, for the bridge, the length of the resistance wire on which contact is made compared with the least variation of the position of contact

[1] How old is the legend of the pole, string, and bird, as a test of an archer's skill? Tom Sawyer, it may be remembered, improved on this, saying that Robin Hood "would take his yew bow and plug a ten cent piece every time—mile and a half." In Joshua xx. 16 there is a reference to seven hundred left-handed men of Benjamin. "Every man could sling stones at a hair's-breadth and not miss." This, I think, is the only Biblical reference to accuracy of marksmanship.

which can be shown with certainty on the galvanometer. Accuracy will depend, among other things, on the accuracy of the weights and balancing resistances employed, while the definition is decided by the workmanship and design of the instrument alone.

In optical instruments, resolving power is judged by the smallest angular or linear quantities which can be distinguished by their means, and definition by the relation which these quantities have to the size of the field over which they are distinguishable. If a telescope, for instance, can distinguish seconds of arc, its resolving power is 206,000 nearly, but if the field over which this resolution extends is only half a degree, the definition would be 1800 (*i.e.* $206,000/57 \times 2$).

Although the performance of any combination of real lenses depends on design and workmanship, it is not difficult to find the limits beyond which even perfection in both does nothing to increase resolving power.

The function of a perfect lens is to change the radius of curvature of a spherical wave surface.

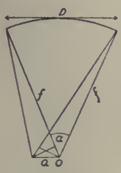

Fig. 4.

Let D (Fig. 4) be the diameter of the lens where the change is effected, f the new radius of curvature, and o the geometrical focus. From every part of the wave surface at D partial waves may be supposed to spread, all of which will reach o in the same phase. Confining the attention for the moment to those rays which start from the opposite ends of a diameter of the lens, the partial waves from either end will be in opposite phases at a distance a, in the focal plane, from o if $2a \sin \alpha/2 = \lambda/2$, where α is the angle subtended at o by D, and λ the wave-length of the light. Also, since $\sin \alpha/2 = D/2f$, $\alpha/f = \lambda/2D$ and $a = f\lambda/2D$. Thus $\lambda/2D$ and $f\lambda/2D$ are the least angular and linear distances from the geometrical focus at which a total absence of light can be found.

If the partial waves are received from the whole marginal annulus of the lens, in place of those from the extremities of a diameter, the value of a_1 is slightly increased, and the image about o of a distant point of light is a bright circular area surrounded by a series of rings. (The rings are caused by recurring coincidence of the phases of the partial waves at certain distances from o greater than a.) The bright centre and rings are identical with those seen in the well-known experiment in which a bright point appears in the centre of the shadow of a disc, illuminated by a bright distant source.

If the whole area of the lens is employed the diameter of the bright centre is further increased, but the intensity of the rings is much reduced. This case, as it applies to telescopes, has been considered by Airey in a paper on "The Intensity of Light in the Neighbourhood of a Caustic," published about the middle of the last century.

In whatever manner, however, the lens is used, whether with a central stop, or with its whole area uncovered, a/f and a are the least angles and distances which separate the geometrical focus from the truly dark boundary of the image, although, owing to the rather rapid diminution of intensity from the centre to the circumference of the image, it is possible to recognise angles smaller than $\lambda/2D$ (this applies to telescopes in which α is always small), or distances less than $\lambda/2$ by the use of microscopic objectives of large angular aperture, where $\sin \alpha/2$ approaches unity.

The appearances presented at the focus when two objects in such close proximity are examined can scarcely be described as the images of the objects, but rather as interference phenomena which require interpretation.

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Discoveries in Tropical Medicine.

In Nature of April 29, p. 549, Sir E. Ray Lankester criticises an obituary notice on Sir Patrick Manson which appeared in the *Times* of April 10. The statement chiefly objected to is that "modern tropical medicine was born the day that Manson discovered the part played by the mosquito in the transmission of *Filaria sanguinis hominis*." But all parasitologists know that it was Manson who, forty-four years ago, proved by experiment the part played by mosquitoes in the propagation of filariasis. This discovery is not only the pride of tropical medicine, but the very breath of modern medicine and one of the most glorious achievements of British science.

Strange to say, Sir Ray Lankester to-day repeats, almost word for word, a mistake he published twenty years ago in the *Times*. He says: "The fact is that Manson's 'suggestion' that the Filaria of elephantiasis [*sic*] is actually carried by mosquitoes from the blood of one person to that of another remains to this day a 'suggestion.' It has not been established as a fact."

It is surprising that a naturalist of repute, who writes frequently on matters medical, should make this mistake. Surely Sir Ray Lankester must have come across books on parasitology written within the last twenty or thirty years. How can he say that the agency of the mosquito, in the dissemination of filariasis, has not yet been established? Was it not surmised by the Chinese ages ago? Was it not suggested by Bancroft of Brisbane (Queensland) in 1877? Was it not independently and experimentally proved by Manson, in China, that very same year? Only one thing remained uncertain for some years, and that was the actual method by means of which the young filariæ, after reaching a certain stage of development within the body of their insect host, left the mosquito to invade man; but this was fully established and admirably demonstrated between 1899 and 1900 by Manson, Low, Bancroft, Annet, and Dutton, James, Noè, Grassi, myself, and others. Dr. Low's beautiful celloidin sections of infected mosquitoes showing the worms, either quiescent between the massive thoracic muscles of the insect, or actively migrating to the latter's mouth parts and fixed while passing beneath the cephalic ganglia, gliding down within the labium, or escaping through a rent between the labella, at the distal extremity of the labium, have been exhibited repeatedly, not only at the Royal Society and elsewhere in this country, but also, on several occasions, in France, Italy, and Belgium. Moreover, they have been photographed and even reproduced in colour by skilled artists, and both photographs and drawings have appeared in books on tropical medicine and parasitology published since 1900.

Sir Ray Lankester refers to two other vexing questions, namely, the discovery of the part played by mosquitoes in the propagation of the intermittent fevers and that of tsetse flies in the transmission of certain trypanosome diseases of animals and man such as nagana and sleeping sickness. With regard

to malaria, he says: "The man who actually 'discovered' the fact of the carriage of malaria germs by a mosquito and the particular species (*Anopheles maculipennis*) so concerned, as well as important facts as to the multiplication of the malarial parasite in the gnat's body, is Sir Ronald Ross." This short statement includes several mistakes. In the first place, *Anopheles maculipennis* is not the only anopheline concerned in the transmission of malaria, because several species belonging to the genera Anopheles, Myzomyia, Pyretophorus, Myzorhynchus and Cellia play an active part in the transmission of the intermittent fevers, within their respective habitats. Then again, *Anopheles maculipennis* was unknown to Ross in India for the simple reason that it is not to be found anywhere within the Indian triangle. *Anopheles maculipennis* is a Holarctic species ranging over North America and throughout Europe and extending round the shores of the Mediterranean Sea and its islands, but otherwise absent from both the Oriental and Ethiopian regions.

Sir Ray Lankester states that Prof. Laveran, the discoverer of the malaria parasites of man, had already previously suggested mosquitoes as the carriers of paludism. I can adduce much older evidence to prove that in malarial stations the natives long suspected the mosquito as the probable cause of infection, just as the tick was suspected of being the carrier of relapsing fever and the body louse the vector of typhus, because the name of the dread "Fever-fly" is inscribed in cuneiform characters on a Babylonian clay tablet of thousands of years ago, now preserved in the British Museum. But Sir Ray Lankester ignores Manson's brilliant interpretation of the "flagellating" malarial parasite, looked upon by the Italians as a form of degeneration; by Manson as the prelude to a further all-important developmental stage outside the body of man. He overlooks the fact that Ross's investigations were inspired by Manson, and that Ross was all along instructed, aided, and supported by Manson. I need but quote Ross's own words in the paper he sent to the French Academy of Medicine, January 24, 1899: "*Pour éviter tout commentaire erroné, qu'il me soit permis de déclarer ici que mes travaux ont été entièrement dirigés par Manson, et que j'ai eu l'assistance de ses conseils et de son influence à toute occasion.*" During the whole period of Ross's work in India, I was almost daily at Manson's house, where I had the privilege and good fortune of being able to follow step by step the unfolding of one of the most wonderful chapters of tropical medicine. I was allowed to read the correspondence, examine the specimens sent by Ross to Manson, and discuss every detail. I do not wish to minimise in any way the importance of Ross's work. Humanity and science are greatly indebted to Ross for his splendid researches and no one appreciated this more than Manson, but all the world knows that Manson was the man at the helm; Ross himself has stated it quite frankly and honourably in his writings.

It was Manson who first clearly grasped the problem, it was Manson who planned the *modus operandi*, it was Manson who chose the man who should carry out his ideas and do the work, and, when failure threatened, as in the case of the Italians, when *they* attempted to solve the problem, it was again Manson who saved the situation, by suggesting that the researches be continued with the Plasmodium parasites of passerine birds. Indeed, the life cycle studied and unravelled by Ross was that of *Plasmodium danilewskyi*, a blood parasite of sparrows and not that of any of the malarial parasites of man. It was in Italy, by Profs. Grassi, Bignami, and Bastianelli, that it was actually proved that the malaria parasites of man go through exactly similar transformations and migrations as those of *Plasmodium danilewskyi*; not, however, in any of the Culicinæ, as Ross had proved for the bird parasites, but in a different subfamily of mosquitoes, the Anophelinæ. Finally, the experiments carried out by Manson in London and by Dr. Low and myself in the Roman Campagna, in 1900, put the last brick in the structure of proof and were especially important in proving that, under natural conditions, the intermittent fevers cannot be contracted in any other way than through the stab of Anopheline mosquitoes. However, it is only right to say that Ross's experiments were undertaken at Manson's request, for the sole purpose of elucidating the etiology of human malaria, that Ross began by using the plasmodium parasites of man, and that the first mosquitoes he infected and examined were "dappled-winged" mosquitoes, that is to say, in all probability, Anopheline mosquitoes. Great discoveries are seldom made by a single man. Ross would never have done this work had he not come across Manson, and probably Manson might have had long to wait for the establishment of his theory had he not found Ross.

With regard to sleeping sickness, Sir Ray Lankester is no better informed. Sir David Bruce did certainly prove that "nagana," the horse disease of Africa, is caused by the same kind of parasite—a trypanosome—discovered by Evans, eleven years previously, in "surra," the horse disease of India, and he repeated very fully the experiments previously made by Dr. David Livingstone and by others to ascertain whether the African natives were right in suspecting the tsetse flies as carriers of the infection, but, unfortunately, Bruce gave wrong interpretations to his own experiments and to those of others, contending that the fly acted merely as a passive carrier, "just as a vaccinating needle"—these are his very words.

It was Prof. Aldo Castellani who first demonstrated the true causative agent of sleeping sickness—a trypanosome which he found not only in the blood, but also, and chiefly, in the cerebro-spinal fluid of sleeping-sickness patients. At the same time, Prof. E. Brumpt of Paris and I, independently, simultaneously, and some months before the publication of Bruce's work, incriminated a tsetse fly as the carrier of sleeping sickness. Prof. Brumpt suggested *Glossina morsitans* as the probable vector, basing his belief partly on Castellani's discovery and partly on his own extended field work in the French Congo. I incriminated the dusky tsetse fly (*Glossina palpalis*), basing my opinion on a careful study of the peculiar topographical distribution and other striking epidemiological features of the disease, on analogy with the better known epidemiology of nagana, and on the bionomics and distribution of the then known species of tsetse flies. At the International Conference on Sleeping Sickness (London, 1907) and at several meetings of the British Medical Association, I endeavoured to prove that the "sexual" dimorphism noticed first by me in the trypanosomes of sleeping sickness (specimens forwarded by Dr. Low to the School of Tropical Medicine) and a critical study of Bruce's experiments on both nagana and sleeping sickness showed that the respective trypanosomes go through a necessary cycle of development (sporogony) within the body of their definitive insect-hosts, analogous to that of malaria parasites in the body of mosquitoes. Six years later (1909) Klein's careful researches in Africa fully proved the justice of my interpretations.

LOUIS W. SAMBON.

The Blue Flame produced by Common Salt on a Coal Fire.

IT is sometimes stated that the blue flame which is seen when common salt is thrown on to a coal fire is due to traces of copper in the coal. It is much more likely that this flame is that of carbon monoxide produced by the cooling of the hot coal by the salt, and certain observations lend support to this view, such as the following:

(1) The blue flame is visible under proper conditions without the addition of salt (and is commonly held to portend frosty weather).

(2) The addition of salt to a fire consisting of white-hot embers—that is, one from which most of the carbon has been burnt—gives no blue flame, which it should do if the flame is due to copper chloride.

(3) The addition of other substances than sodium chloride produces the same effect, a spent filter paper for example.

(4) The colour of the flame seen is apparently identical with that of the carbon monoxide flame but not with the green copper colour.

(5) The sodium flame is never observed in this case because the temperature is too low to volatilise the sodium chloride. For a similar reason it is unlikely that the copper flame can be observed.

Possibly I am wrong, but the matter is interesting, and deserves to be made clear. W. HUGHES.

63 Goldington Avenue, Bedford.

MR. HUGHES's letter raises some interesting questions regarding the conditions under which the "blue flame" of the coal fire appears. There is no reason to suppose that under appropriate conditions the flame of burning carbon monoxide cannot be seen in a coal fire, but it would be difficult to identify since the spectrum is, in the main, continuous. On the other hand, the blue flame of copper chloride, which is distinct from the green flame of the oxide, has a very characteristic spectrum, and there is no difficulty in its identification. There is no doubt, however, that for the appearance of the spectrum of a compound certain accessory conditions have to be fulfilled, and in many cases their effect is by no means obvious. Perhaps one of the most striking instances of this is to be found in the appearance of the spectrum associated with burning sulphur in the flame of an ordinary bunsen burner when the gases of the flame are cooled, *e.g.* by holding a thick plate of cold metal in the flame. In this case the sulphur occurs as an impurity in the coal gas but is not seen in the spectrum of the burning gases unless they are cooled. T. R. MERTON.

Winforton House, Hereford.

Pilot Lamps in Laboratories.

TYPES of neon vacuum tubes recently placed on the market as low candle-power glow lamps for household electric lighting circuits, apart from other uses, have several convenient applications in laboratories as indicators to show when the supply current is flowing in any given circuit. These lamps, which are said by the makers to give only ¼ c.p., have a very high resistance and small current consumption: one type tested on a 200-volt circuit took either 3 or 10 milliamperes, according to the polarity of the connections, while another type took 12 and 30 milliamperes under the same conditions, though individual lamps of the same type vary considerably. In each case the lamp behaved well with a resistance of more than 20,000 ohms in series, and a current consumption of less than one milliampere.

In the case of electric furnaces, muffles, etc., one lamp in parallel with the heating winding serves to show when the current is "on," obviating the chance of the apparatus being left under load when the laboratory is closed at night, and effecting obvious economies by indicating the consumption of current at other times. With electrically heated thermostats, incubators, constant temperature ovens, etc., where the means of heating are not directly visible, a neon lamp serves usefully to indicate contact when making adjustments, while the use of a second lamp shunted across the contact breaker reduces arcing and removes any doubt as to the supply of current when the other lamp is out. Fig. 1 shows a simple method of placing the two lamps in such a circuit. H is the heater winding, B the break, L^1 and L^2 the two neon lamps, while R is a high resistance of 20,000 ohms or more, made by drawing pencil lines on a piece of ebonite between two terminals until a satisfactory glow is given by the lamps.

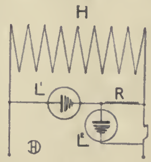

FIG. 1.

The working of such an arrangement is self-explanatory, one of the two lamps always being alight while the current is on. The current consumption on 200 volts is only ⅛th watt—or 5000 hours' service for the cost of one unit.

Where these lamps are required as "pilots" for a large number of circuits, advantage may be taken of the special types designed for advertising purposes, where the electrodes are given the form of letters and other symbols. The makers are prepared to manufacture these in any form if necessary, and such simple words as "on" and "off" could be provided if required. For details of other uses of these interesting lamps reference may be made to a communication in NATURE, March 16, p. 343.

H. J. DENHAM.

Botanical Laboratory, Shirley Institute, Didsbury, May 8.

The Speckled Wave Front of Light.

IN view of Sir J. J. Thomson's suggestion (quoted by Reiche, "Quantentheorie," p. 25) that the wave front of light may have a speckled structure, it may be asked whether anything peculiar happens when two specks, belonging to different waves, collide. They might, for example, be deviated from their courses. If so, one light wave would cause some scattering of another wave with which it collided, and the direct light in the second wave would be dimmed. This effect, if it exists at all, must be small or it would have been noticed. Evidence as to its existence might be obtained in the following way. The supposed dimming of the second ray would be likely to depend on the angle between it and the first ray. On this supposition the brightness of a star lying on the ecliptic would vary slightly with the angle between it and the sun, as seen from the earth. Russell (*Astrophys. Journ.*, vol. xliii., 1916) has shown that the brightness of the moon does so vary, but that has been explained otherwise.

On the Maxwellian view of light the reduction of observations which is here suggested appears so meaningless that it has possibly never been tried.

LEWIS F. RICHARDSON.

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The Royal Academy of Belgium.

By Professor CHARLES SAROLEA, LL.D., Foreign Member of the Royal Belgian Academy.

IN connection with the celebration this week of the one hundred and fiftieth anniversary of the Royal Academy of Belgium a volume has been prepared recording the varied activities of the Academy since its foundation in 1772.[1] Each section of the volume has been allotted to a specialist. M. Paul Pelseneer, the Permanent Secretary, contributes a luminous general introduction and a history of the Prize Foundations of the Institution. M. Stroobant contributes the mathematical and physical section; Prof. Massart writes on the biological sciences and M. Fourmarier on the mineral sciences. The historical sciences have been undertaken by Prof. Pirenne, the philological sciences by Prof. Thomas, the juridical sciences by M. Cornil, the philosophical sciences by Prof. Leclère, the economic sciences by Prof. Mahaim. M. Lucien Solvay and M. Paul Bergmans deal with painting, sculpture, engraving, and architecture.

The celebration of the one hundred and fiftieth anniversary of the Academy is deservedly an event of national import. The Royal Academy of Belgium has been closely identified with the intellectual and artistic life of the Belgian people, much more closely perhaps than any similar body on the Continent, because in Belgium the Academy has been the only important public institution discharging the function of intellectual leadership.

The commemoration will be all the more enthusiastically celebrated because during the war the Royal Academy, although its corporate life was interrupted for four years, incarnated the patriotic conscience of the Belgian people. During the war the German invaders took possession of the imposing palace which the Academy has occupied since 1874, polluted its premises, stole its books and archives, and imprisoned or deported several of its most illustrious members. The reply of the Belgian Academicians was to raise again and again indignant and courageous protests against the brutal policy of the enemy; and their fitting revenge was the recent publication by the Academy of a collection of photographs illustrating the shocking acts of vandalism perpetrated by the apostles of German Kultur.

When the Belgian Academy was founded in 1772 under the reign of Maria Theresa, literary and scientific life was virtually extinct in the Belgian provinces. Historians have often emphasised the contrast between the intensity of artistic life in Belgium and the sterility of literature and science. In the sixteenth century, Belgium still produced men of science of world-wide fame such as Mercator, Ortelius, Simon Stevin, von Helmont, Vesalius, just as Belgian literature in the fourteenth and fifteenth centuries produced a Froissart and a Commines. But from the end of the sixteenth century for two hundred years Belgian literature and Belgian science are almost barren, at the very time when Belgian painting enters its golden age. The explanation of this contrast between the prosperity of art and the paralysis of literature and science is obvious. Art may flourish under conditions of political servitude. On the contrary literature and science demand political freedom. Unfortunately from the end of the sixteenth century the Belgian provinces, unlike the Dutch, were reduced to a state of political slavery.

The foundation of the Belgian Academy in 1772 coincides with the political awakening of the Belgian people. After two centuries the Belgians prepare to shake off the foreign yoke. They are only linked with Austria by a loose political connexion. Unfortunately the Academy is scarcely launched when the French Revolution and the Civil War which follows suspend its activities. Nor can the new Institution be restored under Napoleon. The Emperor had had too many unpleasant relations with the French Academy and with the ideologists of the French Institute to feel disposed to encourage abroad independent scientific or literary institutions. Moreover, apart from his suspicion of Academies in general, he looked upon Belgium as a conquered province and as a mere department of the French Empire.

The Academy was restored in 1816 after Waterloo, by the Dutch Government; and it is interesting to note to-day, at a time when the conflict about the use of the Flemish and the French languages has become acute in Belgium, that even under Dutch supremacy French did remain the sole official language of the Academy of Brussels. But it was not merely the French language which retained its supremacy; the very organisation of the Academy tended to follow French models rather than German or English. When the constitution of the Academy was finally adjusted in 1845, its organisation came to resemble very closely that of the French Institute. It contained the three classes, physical and mathematical science, fine art, and letters. This third class was itself eventually subdivided into the two sections, the historical and philological sciences, and the moral and political sciences. The three classes and four sections of the Belgian Academy therefore answer exactly four of the sections of the French Institute. The chief difference between the two institutions is that there is nothing in the Belgian Academy corresponding to the fifth and most famous section of the French Institute, namely the French Academy. The French Academy mainly represents pure literature, whereas literature pure and simple is excluded from the Belgian Academy. To do justice to the claims of literature, the Flemish Men of Letters constituted themselves in 1888 into a separate Flemish Academy. In 1921, the Franco-Belgian writers followed their colleagues by establishing an Academy of French Literature.

There is one essential feature in which the Belgian Academy resembles the French Institute rather than the Royal Societies of London and Edinburgh; we refer to the strict limitation of its membership. A sure instinct convinced the founders and organisers of the Academy that its influence must needs be in inverse ratio to its numbers. The membership of each class has therefore been restricted to thirty Belgian members with an equal number of foreign associates. It is probable that if the numbers of the Belgian Royal Academy had been increased to some seven or eight hundred as in the case of the Royal Society of Edinburgh,

[1] L'Académie Royale de Belgique depuis sa fondation (1772–1922). Pp. 343. (Bruxelles: M. Lamertin; M. Hayez, 1922).

its authority and prestige would have been very different. It is a high honour to be selected one of a small élite. It is a doubtful compliment to be included in a miscellaneous crowd, and one may not feel very proud to add the letters F.R.S.E. after one's name.

It is not too much to say that the history of the Royal Academy of Brussels for the last hundred years is the history of Belgian science and Belgian learning. Nothing is more remarkable in its activities than the universality of their range. The Academy may claim among its members men of world-wide reputation in every branch of activity. It has produced mathematicians and physicists like Quetelet and Stas; naturalists and chemists like van Beneden and Spring; jurists like Willems and Thonissen; historians like Gachard, Kurth, Cumont, and Pirenne. Looking at the record of those eminent men, Belgium is entitled to a high place amongst the smaller powers of Europe. In one important respect the Royal Academy of Belgium has set an example even to larger and more ancient institutions. It has encouraged research and learning not only by the number and value of its publications. The publications of the Academy constitute indeed a considerable library and are perhaps only rivalled by the editions of that illustrious national seat of learning, the Academy of Cracow. It has published over two hundred volumes of Memoirs, one hundred volumes of bulletins, a collection of about one hundred volumes of the national writers of Belgium, including the Chronicles of Froissart and Commines and Jehan le Bel. In addition it has published a Dictionary of National Biography of which twenty-two volumes have already appeared, and last but not least, it has issued one hundred and thirty volumes of Belgian Chronicles.

The literary activity of the Academy has been all the more useful because Belgian writers, owing to the exiguity of the national territory, can appeal only to a small audience and are generally depending on the support of the French reading public. That activity has been all the more creditable because hitherto the Belgian Academy has had no legal status and for that reason it cannot administer directly any funds or property which may be left to it.

There are good reasons to hope that in the near future the Belgian Academy will at last be endowed with its civil and legal personality. Under that new regime, under the patronage of an enlightened sovereign, and with a national conscience which has been quickened by the tragedy of the war, the Royal Belgian Academy may look forward to an enlarged sphere of scientific and literary usefulness. The present historical record of the institution may therefore be accepted not only as a fitting tribute to the past, but as the promise of an even more brilliant future.

The Cause and Character of Earthquakes.[1]

By R. D. OLDHAM, F.R.S.

THE stress-difference required to produce fracture in average hard rocks, as they are met with at the surface, is round about 1,000,000 grammes per centimetre square, and, allowing for the greater strength at depth, which is indicated by the experiments of Prof. Adams and the computations of Prof. Barrell, we may put the breaking strength of the earth's crust at about double this quantity, so that to reach this point in one year from starting, the strain would have to increase at the rate of about 1400 grammes per centimetre square in each quarter of a day. According to the late Sir George Darwin the stress-differences set up by the moon in the latitude of Italy would amount to about 20 grammes per centimetre square in an incompressible Earth, and in a compressible Earth with an incompressible crust, a condition much more akin to what we have reason to suppose is the reality, the stress-differences would be many times this figure; but even the lower amount is nearly $1\frac{1}{2}$ per cent. of the growth required to reach breaking point in one year; it would be close on 15 per cent. if the period is increased to ten years, and, with anything approaching this proportion, a periodicity would result which could not have escaped detection before now.

The figures, therefore, give us a lower limit of the rate of growth of strain; it must have been something faster than that needed to reach the breaking point in one year from starting, if the differences on which the argument is based are real. But are they real? The actual amount of difference, barely one per cent. of the mean, is so small that it may well be fortuitous, and the true interpretation may be that the gravitational stresses, and the stress-differences produced by them, have no effect whatever in determining the time of occurrence of an earthquake. If this be so, then the rate of growth of strain becomes infinite, and each earthquake becomes the result of a development of strain, akin to an explosion in its suddenness.

The truth may lie anywhere and must lie somewhere between these extremes, so we reach the conclusion that there is no support for the commonly accepted notion of a continuous, slow growth of strain, extending over years, decades, or even centuries, before the breaking point is reached; on the contrary, it appears that the cause of earthquakes must be a rapid growth of strain. This strain cannot be developed without some deformation, but the magnitude of this has no relation to the frequency or magnitude of the earthquakes; if change of form is slow and prolonged, relief may be provided by gradual yielding, if rapid, a very small amount of distortion may lead to fracture, and on the extent, form, and position of this fracture will depend the character of the resulting earthquake.

This study of the rate of growth leads to the question, which is the really important one in its bearing on geology, of how the strain is produced. It can scarcely be the result of those tectonic processes which result in folding, for these must necessarily be slow in their action; the change of form involved in the bending of solid rock from its original shape into complicated folds, without breach of continuity, can only have been a slow one, and, as we have seen, the deformation which produces earthquakes must be a rapid one. With faults the case is different; many

[1] Continued from p. 653.

earthquakes are known to have been accompanied by movement along pre-existing fault-places, in others the origin evidently agrees in position with known faults, and in all of these the distribution of the intensity of disturbance is closely correlated with the faults, being greatest in proximity to them and decreasing as the distance becomes greater. So much is indisputable, yet in spite of a general acceptance of the explanation that the earthquake was a result of the same process which gave rise to the formation of the fault, it must be recognised that the proof is not logically complete, for it might be that the cause and process, which gave rise to the earthquake, were wholly different from, and independent of, those which produced the fault, the only connection being that the weakness, resulting from the fault fracture, served to localise the yielding and so controlled the distribution and intensity of the earthquake. In a study of the Californian earthquake of 1906, where the greatest intensity of disturbance ranged along the line of the San Andreas fault, and was accompanied by considerable displacement and distortion of the surface along the fault-line, I was able to show that the earthquake was due to some cause quite distinct from that which produced the fault, and that neither was the fault the cause of the earthquake, nor the earthquake an incident in the formation of the fault.

Much more weighty and suggestive evidence is to be derived from some other great earthquakes which have been studied in detail. The conclusion drawn from the Californian earthquake is more fully exemplified by the Indian earthquake of 1897. Here there was no single leading fault and zone of maximum intensity of shock, but a complicated network of lines of extreme destructiveness ramifying over an area not much different in area from that of England, and extending right across a series of great tectonic features, across the great monocline of the southern face of the Assam range, across that range itself, across the alluvial plain of the Brahmaputra Valley, the great boundary faults of the Himalayas, and probably even across the main axis of elevation of the range.

A still more instructive instance is the Charleston earthquake of 1886. There, in a region as devoid of any great structural feature, either of folding or faults, and as little subject to earthquakes, as could be found in our own country, there suddenly occurred a great earthquake, of destructive violence in the central area, and felt over an area measuring about 1500 miles across. It was an earthquake of first-class magnitude, whether we regard the maximum violence of shock, or the extent of area affected, yet there is nothing in the structure of the surface rocks which would suggest its origin being in any tectonic process, and equally nothing which could lead to its classification as volcanic. If we accept the conclusions of Col. Harböe, regarding the character and extent of earthquake origins, the absence of any connexion between the origin of the earthquake and the tectonics of the surface rocks becomes absolute, for, according to this interpretation, the origin becomes almost coextensive with the seismic area, and the diminution of violence in the outer portions is not due solely to enfeeblement, resulting from the elastic propagation of the earthquake wave, but very largely to a diminution in magnitude of the originating impulses.

The interpretation is, I believe, in the main, well founded, and, if it be true that earthquakes of great extent are due to systems of fracture, or analogous disturbance, ramifying over, and practically coextensive with, the seismic areas, of which the dimensions in any direction may be measured in hundreds of miles, it becomes more than ever necessary to recognise that earthquake origins cannot be the result of processes and displacements recorded, and indicated by, the tectonics of the surface rocks. The real and ultimate origin must be more deep-seated, and involve either a displacement of, or a change of volume in, the material underlying the outer crust.

This is no occasion to enter into detail, so I have merely indicated the general character of the studies which have gradually forced me to the conclusion that great earthquakes, and also to a large extent those lesser ones which are commonly classed as tectonic, do not owe their origin to the tectonics of the outer crust, but to processes and changes which take place in the material below it. What these processes may be we cannot know with the certainty which comes from direct observation, for such knowledge as we think we have comes from inference, deduction, and, to some extent, simple assumption, but suggestions have been made which possess a considerable degree of probability. Among these, and especially apposite to present considerations, may be placed Dr. L. L. Fermor's studies of the changes in mineral aggregation which may take place in the solidification of a magma; he has suggested that the determining factor in deciding the form in which the rock finally solidifies is the interrelation of pressure and temperature, and has shown that the change of volume, consequent on the change from one mode to another, may amount to more than 20 per cent. in extreme cases. Mr. W. H. Goodchild has also studied the subject from another point of view, and suggested that some of the changes, especially the separation of metallic sulphides, take place with great, even explosive, rapidity.

It is not improbable that, in the material beneath the outer crust, changes of this character are taking place, some slow and gradual, others more rapid and sudden, but all accompanied by a greater or less change of bulk, either of increase or decrease; and if this be accepted we find an explanation, not only of the forms and origin of earthquakes, but of many other phenomena which are difficult of explanation on any hypothesis of contraction and compression alone. On one hand, slow movements of elevation such as that of the northern Scandinavian region may be attributed to slow and gradual change, involving the whole bulk of large masses; the lesser earthquakes may be due to more rapid changes in smaller portions; the greater to transformation involving a larger bulk of material, and possibly a more abrupt change of combination and density; while the greatest earthquakes, of first-class magnitude, result from similar changes involving still a larger bulk of material and greater change of bulk.

To elaborate these considerations forms no part of my purpose; enough has been said to show that, even

in our very fragmentary knowledge of what goes on within the substance of the earth, we have means of explaining and interpreting the greater part of the facts known to us regarding the character of earthquakes. I shall, therefore, conclude by summing up the conclusions which have been put forward as to origin and cause. These are, first, that earthquakes are not due to any slow-acting process of secular duration, but to a rapid development of strain, which may, in extreme cases, be almost instantaneous—a conclusion which I believe to be true of the greater part at least of those usually classed as tectonic, and of all those of great magnitude; and, secondly, that the development of strain is not the result of processes which have produced the tectonic structures, recognised by surface observation, but of changes and displacements in the matter which lies below the cooled and solid outer crust.

Telegraphic Transmission of Photographs.

A NUMBER of experimenters have attained varying measures of success in solving the problem of transmitting photographs, drawings, handwriting, etc., by line and wireless telegraphy, and a good deal of attention has been directed recently to the latest developments of the system on which M. E. Belin has been working in France for some time. His apparatus has been used with good results between the large French wireless station near Bordeaux and a naval station in the United States, as well as over land telephone circuits, etc. A brief description of the latest form of the apparatus appeared in the *Comptes rendus* of the Paris Academy of Sciences of March 6, from which the accompanying illustration is reproduced (Fig. 1).

FIG. 1.—Portable apparatus for the telegraphic transmission of photographs.

As in most of the experimental systems of "telephotography," synchronously rotating drums are made use of in the sending and the receiving apparatus respectively, with a simple arrangement of correcting signals to keep them in step. Mounted on the cylinder of the sending apparatus is a print of the photograph to be transmitted, made on a special bichromatised film which gives an image in appreciable relief. It is not necessary, however, to metalise this image to render it conducting, as is necessary in some systems, and it will be seen that the use of selenium cells, which forms a feature in other systems, is also avoided. A stylus, in a holder which is given a slow axial feed, is caused to pass over all portions of the relief film in succession, after the manner of the needle of a phonograph. This stylus is attached to the diaphragm of a simple but sensitive form of carbon granule microphone, included in a suitable circuit, arranged so that a current of varying strength is produced, owing to the variations of the resistance of the microphone according to the thickness of the part of the film that is being passed over. This varying current can either be sent directly over the line, or can be employed to control the strength of the waves sent out, in the case of wireless transmission.

The manner in which the variations in the signal current, or wave train, are retranslated into a photograph by the receiving apparatus is scarcely more complicated. The varying current from the line (or the wireless receiving apparatus) is passed through a delicate reflecting galvanometer such as a Blondel oscillograph, the mirror of which is deflected by an amount depending on the strength of the current, *i.e.* on the thickness of the film where it is being passed over by the stylus of the transmitting apparatus. The light from the mirror passes through a screen of graduated capacity, and the optical system is arranged so that an image of the mirror, varying in brightness according to the deflection, is projected on to a photographic film on the drum, which is moving synchronously with that in the transmitting instrument. The photographic effect produced at any point is therefore always proportional to the thickness of the original film, so that a duplicate photograph formed of a screen of fine lines, but with a full range of "half-tones," is produced. In a simpler form of the apparatus, for pure black and white or "line" work only, a contact-maker replaces the variable resistance microphone in the transmitting apparatus, and a diaphragm, which

cuts off the light altogether when the mirror is deflected, is used in place of the graduated screen in the receiving apparatus.

M. Belin has perfected a portable form of the transmitting apparatus for connection to any telephone line. Considerable possibilities, both in illustrated journalism and in police work, by the prompt transmission of portraits, finger-prints, handwriting, etc., are opened up by apparatus of this kind, and obviously the system preserves secrecy, as regards all ordinary listening-in apparatus, as the actual signals sent furnish no clue to the nature of the picture being transmitted.

Current Topics and Events.

On May 17 the House of Lords, again prompted by Lord Sudeley, asked the Government to encourage the educational use of museums, and the Government, by the mouth of Lord Hylton, expressed the willingness of the Treasury "to consider in a very sympathetic spirit any further requests" for the appointment of guide-lecturers, also its own "desire to encourage all steps that can be taken to develop the sale of" photographs and other reproductions of objects in the national museums. Fair words! And progress has been made since the debate initiated by Lord Sudeley fourteen months ago. How does the Government translate word into act? It has just cut down the grant for the production of these popular publications, and, if its threat to reimpose admission by payment be enforced, it will deal a severe blow at the whole business and at the usefulness of the guide-lecturers. Never was anything so ridiculous perpetrated in the name of economy. That the sale of publications is a source of income is admitted by the Treasury. At the British Museum (Bloomsbury) an advanced policy has raised the receipts under this head from 3400*l.* in 1920–1921 to 6200*l.* in 1921–1922, thus more than paying for the whole cost of guide-lecturers. The introduction of pay-days will inevitably check this sale, and what will it bring in? The average receipts from admission at the Victoria and Albert Museum during the twelve years the system was in force were about 650*l.* per annum. At the Natural History Museum an expensive stall has just been fitted and saleswomen engaged, and now the authorities expect to have to spend 250*l.* on turnstiles and to lose 400*l.* on sales. One after the other the leaders of industry tell us that the secret of recuperation is more production; yet the Government, when it has a paying business, proposes to economise by checking production.

The Metropolitan-Vickers Electrical Co., Ltd., which has a large works at Trafford Park, Manchester, devoted to the manufacture of electrical machines and apparatus, proposes to take up the manufacture of radio receiving equipment, and for this purpose will work in conjunction with the Radio Communication Co. of London. The Radio Communication Co., which is associated with the Indo-European and Eastern Telegraph Cos., was formed in 1919 to carry on business in connection with the establishment of radio telegraph and telephone installations and is well known for its important work during the war. The manager of the Metropolitan-Vickers Co.'s Research and Education Departments, Mr. A. P. M. Fleming, has been negotiating during the last few months with the Postmaster-General with reference to the establishment of broad-casting stations, and the companies propose to establish two stations immediately, one at Trafford Park, Manchester, and the other at Slough. Other stations are projected as required. Immediately the official arrangements are made with regard to the areas to be covered and sites of the broad-casting stations, active steps will be taken to provide suitable programmes for broad-casting and to manufacture the necessary receiving equipment. The Westinghouse Co. of America initiated the broad-casting of information and entertainment by radio telephony and has very extensive experience in connection with it. The Metropolitan-Vickers Co. is technically very closely associated with the Westinghouse Co. and will be able to draw upon this unique experience, which with the utilisation of a number of fundamental patents in connection with wireless telephony, the experience of the Radio Communication Co. and its own selling, manufacturing, and research organisation, should place the Company in an exceptionally favourable position in entering this new field.

A telegram has been received from Fiji reporting the successful treatment of more than 12,000 hookworm cases by carbon tetrachloride with 90 per cent. of cures with one dose, and the removal of 98 per cent. of the worms. This method was tried first on dogs by Dr. Maurice C. Hall of the United States Bureau of Animal Industry, who found that 0·3 c.c. of the drug for every kilogram of live weight expelled all the hookworms of those animals, a result he had never previously obtained by any other method of treatment, while it could be given after fasting in hard gelatin capsules without purgation being necessary. As the new drug is much less toxic and far cheaper than either thymol or oil of chenopodium, the last of which has given rise to a number of fatalities owing to the uncertain amount of the active principle in different samples, these are matters of great practical importance, and the remarkable success of the trial now reported will, if confirmed by further observations, prove a notable advance in dealing with this the most widespread health- and labour-destroying scourge of immense areas of the world.

With reference to the reported discovery of a stage of the *Leishmania donovani* parasite of kala-azar in the salivary gland of a bed bug in Assam, information has now been received that Lt.-Col. Christophers, I.M.S., has reported the specimens of Mrs. Aidie to show only a normal parasite of the bed bug, which has no relationship to the organism of kala-azar, so the solution of the problem of the carrier of that disease is still incomplete.

THE revised scheme for poultry research of the Ministry of Agriculture, which was foreshadowed by Sir Arthur Griffith Boscawen at the Poultry Club dinner last October, has been approved by the Development Commissioners. Of the grant of 50,000*l.*, 19,500*l.* will be devoted to capital expenditure and the balance to maintenance during five years. The grant is conditional on the sum of 6500*l.* being provided by the industry, and apparently any further grant will depend on results. So that the seedling will have to be planted, pruned to shape, and brought into profit in five years. The provisional scheme includes: (*a*) An experimental section at the Harper Adams College, capital 15,000*l.*, maintenance grant 2000*l.* a year; (*b*) experiments in egg production, 2500*l.* and 725*l.*; (*c*) experiments in the production of table poultry, 1500*l.* and 725*l.*; (*d*) research at the Cambridge School of Agriculture, 5000*l.* and 300*l.*; (*e*) experiments in nutrition at the same school, 500*l.* and 1000*l.*; (*f*) diseases research at the Ministry's Addlestone Laboratory, 1500*l.* and 1250*l.* Much will depend on the personnel of the "advisory committee." Sections (*b*) and (*c*) will be supervised by representatives of the local poultry societies. It is hoped that the scheme may lead to an improvement in British methods of poultry production; hitherto deplorably unscientific.

THE Forestry Commissioners announce that a prize of five thousand dollars is offered by Mr. Frank J. D. Barnjum of Montreal for a practical method of combating and suppressing the spruce bud worm, bark beetle, and borer, which have caused such tremendous damage in the forests of Eastern Canada and the United States. The Province of Quebec alone has suffered a loss during the past ten years of 150,000,000 cords of standing pulpwood by these pests, which represents a market value in pulpwood of three billion dollars, or if manufactured into paper, of seven billion dollars. This represents a loss of wood sufficient for forty-five years' requirements for newsprint for the North American continent. The competition will close on August 1, and the 5000 dollars will be given for the successful suggestion that is accepted by the judges, who will be Sir William Price of Messrs. Price Bros., Quebec; Dr. C. D. Howe, Dean of the Faculty of Forestry, Toronto University; Mr. Fred A. Gilbert, Great Northern Paper Company, Bangor, Maine; Mr. G. C. Piche, Chief of Forest Service, Quebec, and Mr. Ellwood Wilson, Laurentide Company, Grand Mere, Quebec. Competitive suggestions should reach Mr. Frank J. D. Barnjum, New Birks Building, Montreal, Canada, before August 1.

ONE encouraging sign after the war is the increased interest being shown in the Yorkshire Philosophical Societies, most of which were founded about a century ago. The Whitby Society has just had its most successful year; the Scarborough Philosophical Society is also picking up; the Hull Society is celebrating its centenary this year, and the York Philosophical Society next year. This last has issued a pamphlet and an appeal for 75,000*l.* in order to extend its museum and properly to preserve the wealth of archæological material within its grounds. Fortunately, through the generosity of the late Dr. Tempest Anderson, the society was recently very much relieved of its financial anxiety, and under the regime of the new Keeper, Dr. Collinge, efforts are being made to enlarge the museum and to take the necessary steps towards preserving St. Mary's Abbey and the Hospitium. The pamphlet accompanying the appeal contains illustrations from photographs of St. Mary's Abbey, the galleries devoted to mammalia and birds, and the unique bronze mortar belonging to St. Mary's Abbey which is dated 1308—probably one of the earliest dated pieces of this kind in the country. We notice one of the objects of the appeal is to provide "a *Yorkshire* museum up to the standard of modern requirements." Seeing that most of the important towns and cities in the county now have their museums, the museum at York will probably have more than sufficient for its requirements if attention is confined to the antiquities of the city and its immediate area.

THE thirty-third annual conference of the Museums Association will be held at Leicester on July 10–July 14 next, under the presidency of Mr. E. E. Lowe, Director of the Museum, Art Gallery, and Libraries, Leicester. The subjects for discussion at the conference are to deal more particularly (though not entirely) with the practical and technical side of museum work, and the secretary (Dr. W. M. Tattersall, The Museum, The University, Manchester) will be glad to receive offers of papers of this nature as early as possible. An exhibition of appliances, fittings, apparatus, and cases appertaining to museum work, by commercial firms who supply these things is being arranged with a view of the mutual interchange of ideas between Curators and business men. Visits will be made to the Museum, the Art Gallery, the Library, and the newly founded University College, and it is hoped that arrangements will be possible whereby the members attending the conference will be able to inspect one of the staple manufactories of the town. Excursions to the pre-Cambrian area of Charnwood Forest and to the granite area of Mount Sorrel are contemplated. The duties of hon. local secretary have been undertaken by Mr. W. Keay, 6 Millstone Lane, Leicester.

THE annual report of the Zoological Society of London for 1921, presented at the annual general meeting on April 28, records a net increase of 129 in the number of fellows of the Society, while the number of visitors to the gardens, though nearly 200,000 less than the million and a half of 1921, is still the third largest in the history of the Society. The scheme of lectures to school teachers, arranged in 1910 in co-operation with the London County Council, was continued, and Mr. F. Balfour-Browne conducted two courses of four lectures with lantern demonstrations and three tours of the gardens, each course arranged for 150 teachers. The future of the "Zoological Record" has received the serious consideration of the Council, and the volume for 1921 has been

started in the hope that the support appealed for will be sufficient to justify publication and so save this valuable compilation for zoologists both in this country and abroad. Special mention is made of the valuable collection of water-colour drawings of ornithological subjects bequeathed by the artist, the late Major Jones, a collection of almost unique artistic beauty and ornithological interest. The collections of animals from Nepal and Malaya presented by H.R.H. Prince of Wales, will be exhibited in a special part of the gardens during the summer of 1922. Among the proposed new works for 1922, the most important are the provision of better accommodation for the refreshment department and the suggested aquarium on the Mappin Terraces for fresh-water and marine animals. A proposal to place coloured labels on the cages and enclosures containing different species, as a means of identification for visitors, is one that will commend itself. Experiments with coloured drawings painted on tiles and afterwards fired promise success in the production of a form of label which is weatherproof. There can be no doubt that the provision of such labels will prove of great service to visitors to the gardens.

ON Tuesday next, May 30, Sir Percy Sykes will deliver the first of two lectures at the Royal Institution on (1) "Travel in Persia," (2) "Foundation of the Persian Empire." The Friday evening discourse on June 9 will be delivered by Mr. Joseph Barcroft on "Physiological Effects at High Altitudes in Peru."

THE following have been elected officers and new members of council of the Institution of Electrical Engineers for 1922–1923: *President*, Mr. F. Gill; *Vice-Presidents*, Dr. W. H. Eccles, and Mr. A. A. Campbell Swinton; *Honorary Treasurer*, Sir James Devonshire; *Ordinary Members of Council*, Mr. J. W. Beauchamp, Mr. R. A. Chattock, Mr. F. W. Crawter, Mr. D. N. Dunlop, Major K. Edgcumbe, Mr. A. F. Harmer, and Mr. W. R. Rawlings.

AT the annual general meeting of the Chemical Section of the Manchester Literary and Philosophical Society held on May 5, the following officers and members of committee were elected: *Chairman*, Mr. Leonard E. Vlies; *Vice-Chairman*, Dr. H. F. Coward; *Hon. Secretary*, Mr. David M. Paul; *Committee*, Dr. David Bain, Dr. W. H. Bentley, Mr. David Cardwell, Mr. R. H. Clayton, Dr. J. A. R. Henderson, Mr. Harold Moore, Miss Rona Robinson, Prof. F. C. Thompson, and Dr. J. C. Withers.

WE have received from the Eastman Kodak Company, Rochester, New York, their latest price list of Eastman Organic Chemicals. Several new chemicals have been added. The list is noteworthy in that it now includes melting- and boiling-point data for the majority of the chemicals determined from actual laboratory observations. This feature should make it useful to chemists.

Our Astronomical Column.

NEW COMET.—A faint comet, 1922 *b*, was discovered by Mr. Skjellerup at the Cape on May $17^{d.}\ 6^{h.}$ G.M.T., in R.A. $7^{h.}\ 53^{m.}\ 44^{s.}$, N. decl. 19° 32′. Daily motion $+6^{m.}\ 40^{s.}$, N. 1° 28′. The comet is an evening object, and its motion is bringing it into a more favourable position for observation.

CHANGES ON THE MOON.—In a paper by Prof. W. H. Pickering in *Popular Astronomy* for May two drawings are reproduced of the lunar crater Eratosthenes by Dr. Maggini. Prof. Pickering shows that these corroborate strongly his own work, and establish fully the reality of the changes of aspect. He notes that the markings cannot be shadows, since they are visible at full moon, and one of them approaches the setting sun, instead of receding from it; but he has not, perhaps, considered sufficiently the possibilities arising from the different changes of reflective power, according to the angle of incidence, that are shown by different substances. It is generally agreed that at least two lunar phenomena—the increasing visibility of the bright rays as the sun's altitude increases, and the darkening of the floor of the crater Plato under the same conditions—arise in this way. Prof. Pickering estimates the density of the lunar atmosphere as $\frac{1}{150}$ of that on earth, and supposes that enough water vapour and carbon dioxide might be emitted from the craters to support low forms of vegetation.

PROF. BROWN'S NEW LUNAR TABLES.—Prof. Brown in his tables, which are used for the first time in the Nautical Almanac for 1923, deliberately adopted the secular acceleration arising from the change in the eccentricity of the earth's orbit, regarding the larger value deduced from ancient eclipses (generally ascribed to the tidal retardation of the earth's rotation) as too uncertain to use. Many will consider that in this respect he showed some lack of judgment, for Dr. Cowell's discussion of the old eclipses was available before the tables were put into final form. However, he now admits his conversion to the larger acceleration, which has been effected by Dr. Fotheringham's papers on the old eclipses and occultations, and the researches of C. I. Taylor and Dr. H. Jeffreys (misspelt Jeffries by Prof. Brown) on tidal friction in the Irish Sea and similar semi-landlocked waters. In a paper in the *Astronomical Journal*, No. 799, he gives the results of an increase of the moon's secular acceleration from 7·12″ to 11·91″, with the resulting changes in some other constants. He notes that the change makes little difference in his tabular places up to the year 1890, but that it makes a decided improvement since that date, which is another argument, though not a very strong one, for the larger acceleration. Brown's tables thus modified represent the moon's longitude correctly for the end of 1905; after that the moon went ahead of the tables, reaching a maximum of nearly 5″ in 1918; it now shows signs of diminishing again. A small table enables the new correction to be applied to Brown's longitudes of the moon up to the year 1940, when its value is 7·44″. This table will be of use in predicting eclipses, or for other purposes where an accurate prediction is desirable. The paper also gives a list of the errata detected in the new tables; these are chiefly in the explanatory matter, but one refers to the tables themselves.

Research Items.

SEX DEVELOPMENT.—Miss R. M. Fleming, of Aberystwyth University, publishes in the May issue of *Man* the results of her measurements of a large number of women and children, which throw valuable light on the problems of sex development. The results, so far as they admit of tabulation, indicate a decided difference in the rate of development between boys and girls, which may prove of use in their grouping and grading for educational purposes. Until the age of 8 years, girls showed rapid increase in cephalic index and marked changes in colour, while from 9 years onward, the changes were much slower and less marked. Boys showed only slight alterations in colour or in increase of cephalic index until the age of 10, but from 10 years onwards changes were rapid and marked. In the change in the shape of the forehead, boys and girls differ more than in any other feature. The continuous frontal boss of infancy seems to disappear in girls a year or two earlier than in boys, resolving itself in the case of the latter often into two bosses, which mark the nuclei of growth in the frontal bone and interrupt the general tendency of the forehead to recede. It is hoped that the study of these data may help by making it possible to suggest to boys and girls who are undecided about their future careers, lines of thought which will prevent wasting time in trial of a wrong scheme of life.

LIFE TABLES.—Dr. Major Greenwood dealt with the scientific value of life tables at a recent meeting of the Royal Statistical Society. He submitted that the value of a life table as an instrument of research has been over-estimated; a life table is an artificial product and its population is a fiction. It is not correct, for instance, to say that the average length of life of an English male is given by the "expectation of life" of any national table. An "expectation of life" is deduced from the rates of mortality of contemporaneously observed lives and the comparison of such constants for different life tables is open to criticism. Dr. Greenwood is of opinion that a Medical Officer of Health can learn little more from a life table than from death rates at ages.

THE DIALECT OF SOMERSETSHIRE.—The Somerset Folk Press has started a movement for preserving the local dialect by the publication of a series of handbooks, the first of which is entitled "Selected Poems in Somerset Dialect." It contains a number of poems and ballads by James Jennings, born in 1772; George Parker, who died in 1888, aged 92; and other local writers. In an interesting foreword the editor, Mr. Walter Raymond, points out the value of the county as a field for research. Within its million acres it contains a richer variety of natural features than almost any part of England. The variety of its natural structure is the reason for the abundance of its flora and bird life. There is a wealth of local legend, both early Christian and Arthurian. "Many races—since forgotten tribes raised tumuli on the crests of our hills—have made their contributions to our lore. Briton, Scandinavian and Saxon all left their mark on the beliefs and superstitions which still linger amongst our folk. Even the lake-dwellers at Glastonbury may have cast their mite into our treasury of folk-lore." Roman roads and masonry, feudal castles, and ancient Christian remains carry on the story. It would be well if other counties followed the excellent example of Somerset in preserving folk-lore and dialect.

EARTH SMOKING-PIPES.—Convicts in Indian prisons and coolies marching with their loads through passes in the hills, in the absence of the common hukka or water-pipe, indulge their craving for tobacco by making a small tunnel in the earth; a little tobacco is set alight at one orifice, and the smoker, kneeling on the ground, sucks up the smoke from the other end. Mr. Henry Balfour, in the May issue of *Man*, publishes examples of various types of earth-pipes from South Africa and Asia. In South Africa the pipe is either built up on the ground-surface or excavated below it. In Baltistan the tunnel is constructed by thrusting in and then withdrawing a stick from the earth which has previously been patted down. A further extension of the method is illustrated from Natal and Rajputana, where the pipe is a tapering tube of baked clay, sun-dried mud, or camel dung; the wider end serves as "bowl," the narrower as mouthpiece, and there is no demarcation between the two, the bore tapering gradually from one end to the other. Mr. Balfour inclines to suppose that the similarity of practice between Africa and Asia represents a culture-link between the two widely separated areas; but it seems not impossible that similar needs may have suggested this simple method of supplying them. The publication of this paper may lead to the discovery of further examples which may settle the origin of this curious practice.

THE EXTERNAL WORLD.—Physicists and philosophers interested in the problem of the hypothesis of the external world as it is discussed in the works of Helmholtz, Mach, and Einstein may be glad to have their attention directed to two articles by Karl Gerhards of Aachen in the Berlin scientific weekly *Die Naturwissenschaften* for April 28 and May 5, entitled "Der mathematische Kern der Auszenweltshypothese." It is impossible to explain the author's scheme without his diagrams, but it is certainly ingenious, however unconvinced it may leave us in regard to its theoretical or practical value. He attempts to relate the two parallel series, the flow of sensible appearances and the flow of physical reality, by constructing a mathematical model on the analogy of the kinematograph camera. For the observer behind the camera there is a series of "phanograms"; these correspond, of course, to Mach's series of sensations. The author then correlates these by a mathematical device with the reality presumed to lie beyond the kinematographic panorama in a three-dimensional world and obtains a series of "ontograms." What he claims is that by his purely mathematical scheme, or as he terms it by this mathematical kernel of reality, he has got rid of the arbitrariness of the parallelist hypothesis, and shown the actual relation between appearance and reality.

THE STEEL INDUSTRY OF SOUTH YORKSHIRE.—In an article in the *Sociological Review* for April, Prof. C. H. Desch traces the geographical and other factors which have led to the origin and growth of the steel industry in and around Sheffield. The article is of value because these factors are often misstated and their persistence is assumed. The use of local iron ore was encouraged in early times by the abundance of timber for charcoal in the forested valleys, and by the hill-top sites where open furnaces could catch the prevailing winds. These conditions were not confined to this particular part of England, but later, when artificial replaced natural draught, the abundant water power of the five streams converging on Sheffield gave unique advantages for bellows driven by water-wheels. The hammer ponds and the ruins of the

forges can be seen in most of the valleys to-day. When the manufacture of cutlery was established higher grade iron ore had to be imported. This occupation demands a high degree of skill, and it became a domestic manufacture. Many survivals of those economic conditions still exist and give a peculiar character to the organisation of labour in Sheffield to-day. Steam power eventually replaced water power, and the industry as a result has crowded on the lower ground. Coke replaced charcoal as metallurgical fuel. Local coal, firestone, and ganister all helped to retain the industry in Sheffield, but as potent a factor as any other is the traditional skill of the workers. This factor still holds the industry to the district, although few of the former advantages of its localisation are now of value.

TERTIARY MOLLUSCA OF SANTO DOMINGO.—A "Revision of W. M. Gabb's Tertiary Mollusca of Santo Domingo," long wanted by students of tropical American palæontology, has now been published in the Proceedings of the Academy of Natural Sciences of Philadelphia (1921, Pt. II., pp. 305-435, pls. xvi.-xlvii., and text figs.). It is the work of the well-known conchologist Dr. H. A. Pilsbry, to whom great praise and thanks are due. Gabb's investigations were conducted in the years 1869–71 and his observations and descriptions published by the American Philosophical Society (Trans. xv.) in 1873. His fossils were presented to the Academy of Natural Sciences of Philadelphia, but unfortunately were not figured, while the descriptions were not always sufficiently full to ensure recognition. Prior to Gabb, Mr. T. S. Heneken had brought fossils from the island to London, and these were described by Moore, G. B. Sowerby, and later by Mr. R. J. L. Guppy. The present work was begun in co-operation with Mr. C. W. Johnson and submitted for publication in 1917; printing had, however, to be deferred and only an extract containing descriptions of the new species appeared at the time. The full work is now presented with some modifications entailed by the work of Miss Maury. The nomenclature has intentionally been left uniform with the 1917 paper, but surely even at that date the use of Pteropoda as a class apart from the Gastropoda was antiquated. A few further new species are included, but the value of the work lies in the more careful diagnoses of the species and the excellent figures, over 480 in number, which do infinite credit to the artist, Helen Winchester.

AUSTRALASIAN NATURAL HISTORY.—The Papers and Proceedings of the Royal Society of Tasmania for the year 1921, recently received, include some articles of great interest and importance. H. H. Scott and C. E. Lord, writing on "Nototheria and Allied Animals," are convinced that several groups of more or less generalised animals lived in the Australian zoogeographical province and "that the names Diprotodon, Nototherium, Phascolonus, Euryzygoma, etc., stand as outpost flags of a largely unexplored realm," and "that the most generalised groups have yet to be reconstructed." Dr. R. W. Shufeldt describes "Skeletons of the Monotremes in the Collections of the Army Medical Museum at Washington [U.S.A.]." Two skeletons of Ornithorhynchus and one of Echidna are described at some length and figured, on the ground that these animals are now becoming rare. W. L. Crowther and C. Lord give a "Description of Two Tasmanian Aboriginal Crania," which will intrigue anthropologists. Prehistorians of the school to which Mr. Reid Moir belongs will find much support from the figures and descriptions of "The Concave Stone Implements of the Tasmanian Aborigines," described by Dr. G. Horne. The Tasmanian specimens are compared with similar ones from south-east Victoria and their mode of use illustrated by reference to the methods of the aborigines of the latter district. Judging from the figures these implements are of the crudest character even when allowance is made for the nature of the material from which they have been chipped. "A Preliminary Sketch of the Glacial Remains preserved in the National Park of Tasmania," by A. N. Lewis, with "Some Geographical Notes on a Model of the National Park at Mt. Field, Tasmania," from the pen of Prof. G. Taylor, furnish together an interesting account of the physical geography of a district which, although small, abounds in features of remarkable character, especially the parallelism of the valleys and the arrangement of some of the lakes therein.

SOME AUSTRALIAN DIPTERA.—G. H. Hardy contributes to the Papers and Proceedings of the Royal Society of Tasmania for the year 1921 a monograph on "Australian Bombyliidæ and Cyrtidæ (Diptera)." This catalogue contains a key to the genera, and descriptions of two new species belonging to genera in which no previous species have been described from Australia. Also there are numerous synonyms suggested, and a number of species have been placed in the genera they more readily conform to than those in which they were originally placed.

METEOROLOGY AT FALMOUTH.—Falmouth Observatory has published meteorological notes and tables for the year 1921. The work is carried on under the auspices of the Royal Cornwall Polytechnic Society by Mr. J. B. Phillips. Observations are supplied to the Meteorological Office, and the Observatory is assisted financially by the Government. The mean pressure for the year was 30·126 in., which is 0·15 in. above the average and a record for the past 50 years. Bright sunshine was registered on 315 days, which is 11 days more than the average, and the total duration was 1817 hours—64 hours above the average. Every month had an excess of temperature, the mean for the year being 53°·6 F., which is 2°·9 above the normal for 50 years. Rain was measured on 186 days, a total 22 short of the average, and the total measurement was 28·9 in., which is 16·7 in. less than the normal for 50 years. The highest hourly wind velocity was 55 miles in a south-westerly gale on March 28, and the strongest gust was at the rate of 77 miles an hour.

AN EFFICIENT SOUND PRODUCER.—In our issue of April 12, 1917, p. 132, attention was directed to the work of Prof. King of McGill University on the efficiency of the compressed air syren used at Father Point, Quebec, for signalling during fog. Of the 100-horse power used only 2·4 was converted into sound. From a paper by Prof. Kerr Grant, of the University of Adelaide, published in the April number of the Proceedings of the Physical Society of London, there appears to be some possibility of producing sound more efficiently. The new apparatus makes use of the vibrations set up in a thin metal plate a foot in diameter. A stream of air or liquid issuing from a flanged pipe, the flange of which is placed near and parallel to the plate, impinges on the latter. The arrangement is a reproduction on a mechanical scale of the scientific toy illustrating Bernouilli's law of flow of fluids, in which a sheet of paper is placed on the end of a flanged pipe and attempts are made to displace the paper by blowing up the tube. In the sound producer, the surface of the flange is made convex to the plate, and the edge of the latter is provided with a strong rim to which the pipe and flange are attached in a way to provide for adjustment of the distance separating flange and plate.

The Royal Society Conversazione.

THE first of the two annual conversaziones of the Royal Society was held at Burlington House on May 17, when Sir Charles Sherrington and the officers of the Society received the fellows and guests. A few of the exhibits were shown last year, and it is an invidious task to select some of the remainder for mention. We have therefore grouped the exhibits on related subjects and propose to describe briefly a few of the items in each group.

Sir Almroth Wright demonstrated methods of measuring the bactericidal potency of the blood fluids and leucocytes. With regard to the microbes that give rise to "blood poisoning" and septicæmia, the capacity for growing in the blood fluids depends on capacity for overcoming the normal anti-tryptic power of the blood and digesting its albuminous substances. Increased destruction of microbes can be obtained by the vaccination of the blood *in vitro*. This is important, for where the patient is unable to respond to a vaccine he can be transfused with a normal blood which has by vaccination *in vitro* been furnished with the protective substances required. The lysozymic action of tissues and secretions was demonstrated by Dr. Alexander Fleming. This inhibitory effect on bacteria is so strong that with tears diluted 1 in 100 it is complete in a few seconds, and it is shown even with tears diluted 1 in 5,000,000 or egg white diluted 1 in 50,000,000.

Specimens of giant frogs were exhibited by the Department of Zoology, Natural History Museum (Mr. C. Tate Regan). *Rana goliath*, from S. Cameroon, is the largest known frog, attaining a length of nearly 12 inches, without the limbs. *Rana guppyi*, from the Solomon Islands, is remarkable in that it feeds almost exclusively on crabs, which are swallowed whole.

Some results of researches on the biology of aphides, with particular reference to *Aphis rumicis*, were illustrated in the exhibit of the Entomological Department, Institute of Plant Pathology, Rothamsted (Dr. A. D. Imms and Dr. J. Davidson). Breeding experiments have shown the relationship between the agamic and gamic generations, and the appearance of winged and apterous forms; the changes associated with these phases are due to internal factors. Variations occur in the same species on different plant hosts.

Internal casts of a gigantic freshwater gastropod from Wealden Rocks, near Silver Hill, Hastings, were exhibited by the Department of Geology, British Museum (Natural History). Twenty-three whorls, including the body-whorl, are traceable, with a total length of 7 ft. 3 in. The affinities of the mollusc are probably with the Tiaridæ.

Astronomy was represented by exhibits from the Royal Observatory, Greenwich. Photographs with the 30-inch reflector were used to show a relation between the effective wave-lengths of stars and their spectral type. When a coarse grating is placed before an objective, short diffraction spectra are produced in the focus on either side of a central image, the distance between the diffracted and central images being a function of the wave-length of the light. This furnishes a convenient means for determining the colours of the stars as defined by the wave-length of maximum photographic intensity. A chart of variation of latitude at the observatory during 1911–1921 was also shown. The curve can be analysed into two principal components, one with a period of 432 days, and the other with a period of one year. The amplitude of the first component is about twice that of the second.

Sir William Bragg and Prof. W. L. Bragg exhibited a number of models, on a scale of $10^8 : 1$, illustrating crystal structure. By X-ray analysis, the size of the cell containing the unit of pattern of the crystal is found accurately. The distance between the centres of neighbouring atoms is also known and accurate models can be constructed which, in the case of organic crystals, are based on the principle that benzene and naphthalene molecules are frameworks of definite dimensions.

Prof. H. B. Baker gave a demonstration of the changes produced by prolonged drying on the boiling-points of liquids. Dried benzene does not boil when immersed in boiling water, and other liquids including mercury, bromine, alcohol, and ether show a rise in boiling-point which varies from 26° to 62° C. The surface tension also increases, indicating that the change may be due to increase in the size of the molecules.

The National Physical Laboratory had a number of exhibits. A precision bridge for platinum thermometry designed by Mr. F. E. Smith was shown by Mr. W. F. Higgins and Mr. F. H. Schofield. The resistances of the two variable arms of the bridge system used are of the order of 100 times that of the thermometer, so that brush contacts can be used without appreciable sacrifice of precision. The steps on the lowest dial correspond to 0·001° C. The Research Department, Woolwich, Radiological Branch, exhibited a metal X-ray tube of novel form, with an iron target. The tube is of the hot cathode type, and is constructed chiefly of metal, the insulation between the anode and the case being secured by a glass sleeve. Both the anode and the metal case are water-cooled. The tube is self-shielding, only a narrow pencil of X-rays escaping from an aluminium window. It is designed to give very soft radiations, and to run continuously with a heavy current. The Cambridge and Paul Instrument Company, Ltd., showed a micro-indicator for taking diagrams from high-speed engines. The vertical movement of the end of a small indicator piston deflects a strong triangular spring carrying a stylus which scratches a micro-diagram of a single complete cycle upon a disc of transparent celluloid. The actual size of the diagram is approximately 3 mm. base (time) by 2½ mm. height (pressure).

Mr. W. M. Mordey demonstrated some striking effects of alternating magnetism. Magnetic materials, including finely divided iron, nickel, cobalt, magnetite and specular hæmatite, show a steady movement or migration through or from a multiphase field in a direction opposite to that due to eddy currents. In a multiphase field vertical "planes of force" are formed, but there is no movement of finely divided aluminium nor lead shot. Water containing any of these materials may be driven uphill in a multiphase field, an effect which is probably due to surface-tension. The method can be applied to the concentration or separation of certain minerals, wet or dry (NATURE, April 29, p. 556).

During the course of the evening Lord Rayleigh gave an account of his recent spectroscopic investigations of the aurora borealis, with particular reference to its occurrence on ordinary nights in the South of England.

It is impossible in the space of a short article to do more than indicate some of the many interesting and important exhibits which were displayed. There were several novel pieces of physical and electrical apparatus which have not been mentioned, and the whole combined to form a noteworthy and interesting display.

Motor Headlights.

A DISCUSSION took place on the above subject at a meeting of the Optical Society on May 11. Mr. J. W. T. Walsh, of the National Physical Laboratory, in his opening paper, recalled that the design of headlights had been much discussed recently, for example, at meetings of the Illuminating Engineering Society from 1911 onwards. The problem resolved itself into a compromise between the needs of the motorist, who required a sufficiently powerful beam to distinguish objects in time to pull up or slacken speed, and the desire of the pedestrian or driver of approaching vehicles not to be dazzled by glare. In discussing the nature of glare, essentially a physiological problem, Mr. Walsh showed diagrams relating contrast sensibility of the eye and brightness, and the effect of obliquity of the bright source in the field of view. Attempts had been made to fix a "glare limit" for a field of a given brightness, and it was generally recognised that glare was largely a matter of contrast. The limitation of the powerful driving beam below a certain plane, so as to obviate intense light striking direct into the eyes of approaching persons, had been advocated and embodied in various codes, but it is recognised that, in addition to the main beam, moderate diffused general illumination is desirable. Requirements for headlights had been somewhat fully dealt with in American regulations. For instance, it had been prescribed that the illumination measured 100 yards away should not fall below a certain value, and in the latest specifications drafted by the American Illuminating Engineering Society minimum values for the main beam-candlepower, and maximum candlepower values at other angles (with the view of limiting glare), had been stated. Some polar curves, showing the distribution of light from typical modern headlights, were shown, a maximum candlepower of 5000 being attained in some cases. Another device for testing the power of the beam, intended to be applied on the road and where photometric measurements were impracticable, was the Royal Automobile Club standard disc, which comprised patterns of white lines on a black background, the requirement being that the patterns should be distinguishable by the available illumination at a specified distance from the car. The disc was referred to in the latest report of the Ministry of Transport Committee on Lights on Vehicles. It was generally agreed that legislation was a difficult matter but much could be done to improve conditions by making the fundamental principles of design well known.

In the ensuing discussion Commdr. T. Y. Baker (Admiralty Research Dept.) described a simple apparatus for measuring brightness, the object to be tested being viewed through a tube, and its brightness compared with that of a lamp emitting light down a side-tube.

Mr. Leon Gaster (Hon. Secretary of the Illuminating Engineering Society) remarked that the subject had been much discussed in various countries, not only by the Illuminating Engineering Society in the United States (as Mr. Walsh had mentioned) but in recent proceedings of the German Illuminating Engineering Society. At the first technical session of the International Illumination Commission in Paris last year it was resolved to appoint an international technical committee to deal with the problem. The Illuminating Engineering Society in this country had formed a joint committee on motor-headlights, and he gladly took the opportunity of inviting the Optical Society to nominate a representative. Mr. Gaster also pointed out that regulations prescribing a certain illumination at a specified distance ahead of the car depended essentially on the speed of driving. The distance was presumably based on the length of road in which a car driving at 20 miles an hour could pull up. With the removal of the speed limit such requirements might need revision.

The Chairman (Mr. Whipple), having thanked Mr. Gaster for the invitation conveyed to the Optical Society to appoint a representative on the Illuminating Engineering Society joint committee, called upon Mr. J. S. Dow to continue the discussion. Mr. Dow pointed out that glare was mainly a matter of contrast and should therefore be considered in relation to street lighting. He believed that in certain cases a device had been employed to direct light on the front of a car, enabling its outline to be seen more clearly and diminishing the contrast between the brightness of the headlight and its surroundings. It had also been suggested that glare depended to some extent on colour, and that a slight yellow tint, though involving some loss of light, was preferable in this respect, as well as giving somewhat better definition of distant illuminated objects.

Sir Wm. Barrett, in the absence of Sir Howard Grubb, described and demonstrated the Grubb headlight, of which he had had favourable personal experience. The primary principle now usually aimed at in modern headlights, is that the main beam should be confined below a height of 3 feet above the roadway, so that the beam did not shine in the eyes of persons approaching, a milder and more diffused light being distributed outside this limit. The original headlight utilised two "D"-shaped lenses separated by a strip of grooved glass to effect this division, but more recently the design has been improved, two horizontal strips being inserted, and the arrangement of the lenses has also been modified. Sir Wm. Barrett presented a table summarising the requirements of the code for headlights adopted in Massachusetts, including a maximum beam-candlepower of 5000, and showed that these had been complied with in this form of headlight.

In the ensuing discussion a great variety of headlights was demonstrated. Generally speaking, the aim was to provide a powerful beam, but to restrict the candlepower in directions above a certain horizontal plane. It was evident, however, that the distribution of light effected by the various devices differed considerably. One ingenious device comprised the use of a supplementary concave reflector covering the upper half of the headlight whereby light-rays in the upper hemisphere were directed back on to the main reflector and added to the main beam. Various devices to assist the provision of suitable side-illumination, in addition to the main beam, were also described. Thus in the Zeiss headlight there is a special annular reflecting surface which furnishes diffused illumination on either side of the car. Another feature is the use of a Bowden wire arrangement to enable the motorist to cut out the dazzling effect of the headlight while retaining sufficient light for a shortened track. This effect can be produced at any time, and is recommended for use in the well-lighted streets of large towns, where there is considerable traffic.

One other device that may be mentioned is the Kent glare screen, which consists of a small plate of coloured glass, which can be attached to the windscreen so that the driver, by slightly moving his head, can bring an opposing headlight within the field covered by this screen and thus reduce its dazzling effect.

Some Post-War Problems of Transport.

SIR JOHN ASPINALL'S long and unique experience in transport problems renders his "James Forrest" lecture—delivered at the Institution of Civil Engineers on May 2—of importance to the general public, all of whom are interested in passenger traffic and affected by the cost of the carriage of goods.

Sir John Aspinall dealt first with London passenger traffic. In the early days of the lay-out of railways the short distance passenger was scarcely considered, and it was only by degrees that his demand for greater facilities was met. Other lines of way have been added, and the notable addition of the tubes has been very effective. Travel has been helped also by attention to details. The modern station with its escalators is a vast improvement on the older types with long and tortuous passages, and plain, well-lighted directions enable passengers to find their way easily. In the carriages, high backs to the seats prevent vacant seats being seen; strap-hanging is preferable to pillars, which are apt to produce blockages. The necessity of quick loading and unloading of a car means that the doorway and platform arrangements have to be considered. It is a matter of common knowledge that getting into and out of a carriage during the rush hours at present is an exceedingly trying operation. Sir John Aspinall suggests the use of three platforms, two outer and an island platform. Passengers from both trains alight on the island platform and the trains are loaded from the outer platforms. This plan should be very effective in separating the streams of passengers. Proposals have also been considered by the tube companies for deeper tubes with fewer stations, suitable for quicker long distance travel.

The excellent reports and maps prepared by the London traffic branch of the Board of Trade indicate that future provision for the growing population will require to be made towards the north-west and south-west, both of which have much blank travel space on the map. Admirable as may be the organisation which cuts down time spent in the steam operation of suburban trains, it would appear that London traffic must henceforward rely on electrification to make more frequent service possible.

Traffic on the roads follows the same lines as the railway traffic. Here the motor bus helps greatly. In 1921 the London General Omnibus Company handled 761,250,000 passengers, which is nearly half the number dealt with by all the railways in Great Britain. The total passenger mileage on all the railways was 227,397,353, and the buses ran 87,000,000 miles, approximately one-third that of the railways. The improvement of the motor bus has been so great that it is safe to assume that the much more expensive tramway system will not be greatly extended.

Notwithstanding the help of the most modern buses, the extension of railway facilities in London is urgent. The engineering world has not been backward in proposing new means of dealing with London traffic. Most of the schemes prepared before 1903 represent an enormous waste of money, not because they were bad, but because of our methods of private bill legislature, which often result in the defeat of well-planned proposals on grounds which subsequent events showed to be unsound. Sir John Aspinall does not despair of some first-rate scheme being adopted for future gradual development if it were in the first instance considered and proposed by a strong committee of those who are engaged in handling London traffic to-day, and then legalised. Hitherto so much harm has been done by dealing with this problem in bits that it becomes the more desirable to deal with it as a whole.

There has been great architectural objection to the continued existence of certain railway bridges over the Thames. On the other hand, the daily number of people crossing these is much larger than could pass over road bridges. Hence their abolition would inconvenience the travelling public. The objection on account of unsightliness is legitimate, and can be avoided. A well-known engineer has shown how a double-decked bridge can be constructed at Charing Cross with all those architectural features which our architect friends desire. In this bridge the railways cross at the same level as at present; the roadways are at a higher level and descend with easy gradients on both sides of the river.

So far as we have gone, it appears to be true that passenger traffic facilities have never been in advance of London requirements.

Sir John Aspinall gives strong evidence in favour of long distance electrification on main-line railways. The train capacity of any railway and particularly of any terminal station is vastly increased by electrification, and thus the capital cost of extensions and widenings can be postponed for years. Shunting is very costly; of a total of 288,000,000 freight engine miles run in Great Britain, half was on remunerative work and 117,000,000 miles on shunting. The ultimate ownership of all wagons by the railway companies—thus cutting out the private owner—will eliminate much shunting expenditure. Much economy may also be anticipated from the new group system. Sir John Aspinall has also something to say about local rates. There are many country districts through which railways run but have no stations and therefore are not road users, where the railways have to pay from 5 to 90 per cent. of the parish rates. The equity of the case appears to demand that those who do the damage to the roads should pay the cost. On the Great North Road the "tons per yard width of road per day" was 77·7 in 1912 and 300·8 in 1920, and of the latter figure 51·5 per cent. was due to heavy motors and tractors, for which the figure was 16·9 per cent. in 1912. Goods transport by road involves 300,000 vehicles at present, and road maintenance costs 50,000,000*l.* per annum.

There is not a great deal of water power available in this country for the production of electric current, and we must still largely rely on coal.

There seems to be much misunderstanding as to the merits of canals. The fact is, however, that the days of the small barge canal are gone. The greater canals, which permit of the passage of large cargo steamers, are on an entirely different basis. Sir John suggests the conversion of disused canals into roads, which of course would be level excepting where there are locks.

Many modern writers have pressed that civil aviation should receive considerable national assistance, but the same methods of gradual and persistent investigation which have been applied for so many years to the ships of the sea must be applied to the ships of the air. There will probably be common agreement that at no time in the history of this country has national transport been so intimately connected with the necessities of national defence.

Colston University Research Society.

BRISTOL is peculiarly fortunate in possessing a unique organisation for the encouragement of research at its University. Originally founded in 1899 and named in honour of the famous philanthropist, Edward Colston, its funds were at first applied to the support of the then University College in connection with its proposed expansion to a University. This accomplished, the Colston University Research Society undertook the distinctive function of supporting research work within the University, and since 1910 some 3700*l.* have been raised and applied to scientific investigations, which in most cases could not otherwise have been carried out; these include contributions to medicine, engineering, and to the general advancement of knowledge.

The essential importance of scientific research, realised a generation ago by Germany, was brought prominently before every citizen during the Great War. The serious industrial difficulties of the past two years have brought home to most people the fundamental interdependence of production and prosperity. For cheap production we need to-day increased invention in every direction. Modern invention is based on scientific research, and it is to the development of scientific research that all who are engaged in industry must look for the permanent revival of British industrial supremacy. Every process we employ, every device and invention of which we take daily advantage, is the result of some former, maybe forgotten, research. Enlightened opinion recognises that some seed corn must be returned if the future is to repeat the successes of the past. It is a sign of the times that men should now rally to the support of the most essential function of our universities.

The Colston University Research Society consists of members of the public and of industrial firms of Bristol and the west of England who subscribe the necessary research funds. On May 23 each year the annual dinner is held, at which the City of Bristol, the Society of Merchant Venturers, and the Bristol Chamber of Commerce are represented. The chief guests include one or more distinguished educationists or investigators. This year the Minister of Education and Prof. G. Elliot Smith were two of the invited guests of the evening.

The society affords an opportunity for every citizen to give direct support to research work for the advancement of knowledge, and similar organisations might with great advantage be established in all university towns. The society accepts the term "Research" in the widest sense, and looks forward to the time when research work in the Arts side may also receive assistance through the society from the community at large.

A new departure under this year's president, Mr. Ernest Walls, is the establishment of Colston research fellowships, whereby it is hoped that the University may render service to local industries. Industrial firms are invited to endow post-graduate research fellowships at the University, the fellow receiving 150*l.* per annum. The fellowships may be earmarked to a particular faculty or branch of research or to a particular research problem. In the last case, this is subject to the approval of the professor agreeing to supervise the work, and if it is an industrial problem the donor bears all expense. A form of agreement between the University, the donor, and the research fellow may be required.

The donor of a fellowship will have access to the research work and will receive the results of the work twelve months prior to publication. Five firms have already undertaken to endow fellowships, three in chemistry, one in engineering, and one not earmarked. These fellowships should serve to link the University more closely to the life of the city without sacrifice of academic freedom, and, apart from the advantages accruing to the firms, will undoubtedly lead to permanent industrial appointments for some of the best graduates.

It will be interesting to see whether this plan may not suit the conditions of the British Universities better than the well-known system of industrial fellowships of the Mellon Institute in the United States.

A record annual collection announced at the Colston University Research dinner at Bristol on Tuesday amounted to 939*l.* 1s., the largest individual amount being 25*l.* In addition, 1100*l.* were collected for Colston Research Fellowships.

Active Hydrogen.

IN a short communication by Mr. Y. Venkataramaiah, read before the Science Association, Maharajah's College, Vizianagram, S. India, in January 1920, and published in the Proceedings of the Association for July 1921, the formation of active hydrogen by passing hydrogen through an ozoniser is described. The active form combined with sulphur and phosphorus at the ordinary temperature. In a previous communication to NATURE (of September 9, 1920, p. 46) the same author described an active form of hydrogen, formed by the explosion of oxygen with excess of hydrogen, which reduced potassium permanganate solution rapidly at room temperature. These discoveries were, apparently, made independently of those of Wendt and Landauer (Journal of the American Chemical Society, 1920, 42, 920), who obtained active hydrogen by the action of the corona discharge on hydrogen at low pressure, and by the action of α-rays on hydrogen.

The American authors now describe (Journal of the American Chemical Society, March 1922) the production of active hydrogen by the action of the silent discharge (as previously described by Venkataramaiah), by the action of a high-frequency Tesla discharge, and by the action of thermionic emission, on hydrogen. In all cases only small amounts of active hydrogen are formed, and it is rapidly decomposed. Since it is formed with contraction, and is condensed in liquid air, the authors consider it to be represented by the formula H_3, although they give no evidence for this particular composition. They do not accept the suggestion, made by E. C. C. Baly ("Annual Reports of the Chemical Society," 1921), that their product is identical with the purely hypothetical "iso-hydrogen" of Harkins, which, although represented by the symbol H_3, is supposed to consist of a single atom with an atomic weight of 3 units.

This use of chemical symbols with an unusual meaning, as in the similar case of the isotopes of chlorine, which are often described as Cl_{35}, etc., is, in fact, most confusing, and it is very desirable that some less objectionable notation should be adopted. We suggest that the symbol Cl(35), for example, which could be adapted to formulæ such as Cl(35)Cl(37), would meet the case.

University and Educational Intelligence.

Cambridge.—The Council of the Senate has approached the President of the Board of Education, stating that the immediate appointment of a Statutory Commission for Cambridge would be welcome on the understanding that the University and Colleges would have an opportunity of bringing their views on the detailed recommendations of the present Commission before the Statutory Commission.

A welcome bequest to the Fitzwilliam Museum from the late Mr. S. G. Perceval of Trinity Hall is announced. His collection of pictures, books, manuscripts and objects of art at present on loan to the museum is now bequeathed to the Museum, and an estate with an income of 400*l.* a year.

Mr. W. W. Rouse Ball of Trinity College offers the University the sum of 500*l.* to constitute a Trust Fund for the provision of occasional lectures dealing either with some particular development of mathematics or application of mathematics to science.

Dr. G. P. Bidder of Trinity College has offered 5000 lire, subject to equal help from the Balfour Trustees, in order that a research student may be sent to the Stazione Zoologica at Naples for six months in the coming autumn.

Dr. E. Lloyd Jones, Downing College, has been reappointed demonstrator of medicine. It is proposed to appoint Mr. E. A. Milne, Trinity College, university lecturer in astrophysics.

Mr. B. K. Martin, Magdalene College, has been nominated to hold the Princeton Visiting Fellowship for the year 1922–23, and there has been recently notified a visiting scholarship at Yale University to be held preferably by a man who has not completed his course at Cambridge but intends to return to Cambridge at the end of a year at Yale. The Joseph H. Choate Memorial Fellowship at Harvard University will also shortly be filled.

A grant of 150*l.* is to be made to Mr. J. M. Wordie, St. John's College, towards the expenses of an expedition to Greenland for work in geology, botany, zoology, and ethnography.

Leeds.—The Council of the University has elected Dr. Albert Gilligan to the chair of geology. Dr. Gilligan, who was educated at Wolverhampton Grammar School and University College, Cardiff, has been lecturer in economic geology and reader in petrology in the University. He has published important researches on the Carboniferous rocks of the north of England and upon the petrography of the Millstone Grit in Yorkshire, and has been awarded the Murchison Fund by the Royal Geological Society. Dr. Gilligan succeeds Prof. P. F. Kendall, and the Council of the University has placed on record its appreciation of the value of the work performed by Prof. Kendall during his thirty years' connection with the Yorkshire College and the University of Leeds.

Mr. S. Barratt has been appointed assistant lecturer and demonstrator in chemistry. Mr. Barratt was educated at Clifton College and at Balliol, Oxford, where he obtained a first-class in the Honours School of Chemistry and a research scholarship which enabled him to work for two years with Prof. T. R. Merton. He was joint author with Prof. Merton of a paper on "The Secondary Spectrum of Hydrogen," which formed the Bakerian Lecture of the Royal Society delivered on March 9 last.

Mr. Alexander Hamilton Thompson, reader in mediæval history in the University of Durham (Armstrong College), who has edited the *Archæological Journal* since 1919 and has published work on Yorkshire antiquities, including the Ecclesiastical History of the county contributed to the "Victoria County History," has been appointed reader in mediæval history.

The following appointments have been made from the staff of the University:—Mr. W. Godden, for a number of years lecturer in agricultural chemistry and advisory chemist in agriculture, to be head of the Biochemical Department of the Rowett Institute for Research in Animal Nutrition at Aberdeen; Mr. D. B. Johnstone-Wallace, district lecturer in agriculture, to be agricultural organiser for Devonshire.

Queen's College, London, which was founded by F. D. Maurice and other King's College professors in 1848, and incorporated by Royal Charter in 1853, was the first institution devoted to the higher education of women. It represents, therefore, the beginning of a movement which has enlarged the sphere of women's activities far beyond anything contemplated in the middle of the nineteenth century. All who have broad and liberal conceptions of education appreciate the value of the pioneer work done by the College and the distinguished men associated with it, such as Charles Kingsley, Edward Forbes, D. T. Ansted, H. G. Seeley, Rev. G. Henslow, W. B. Carpenter, Sterndale Bennett, W. H. H. Hudson, J. D. McClure, and W. A. Miller, to mention only a few scientific leaders whose names are among those of past professors. Throughout its existence the College has stood for independence and true learning, and all are now gathering fruit from the tree which it planted. The appeal which has just been made for the sum of 20,000*l.* to enable the College to purchase the adjoining house in Harley Street, and thus extend and consolidate its activities, ought, therefore, to meet with a ready and generous response. "At no time in our history," says Lord Askwith, chairman of the Appeal Committee, "has it been so important that women should be able to have guidance in their new powers and keen desire for knowledge"; and we hope that a college which has done so much to realise the highest physical, intellectual, and moral ideals will be provided with the resources desired to continue its valuable work. The appeal has the support of Mr. H. H. Asquith and Sir James Frazer among others, and it is one which we particularly commend to all who are interested in the place of women in a reconstructed world. Donations should be sent to: The Queen's College Extension Appeal Fund, London County Westminster and Parr's Bank, Ltd., Cavendish Square, London, W.

The Board of Education has approved an arrangement whereby students of University College, Reading, receiving grants under the Board's Regulations for the Training of Teachers, will be permitted, if suitable for a course of agricultural study, to take the London University External B.Sc. degree course in agriculture as an alternative to a course in arts or pure science. Students wishing to follow this course must enter the training department of the College for a course of three years, which, if successfully completed, enables them to obtain the degree and also to secure recognition by the Board of Education as Certificated Teachers. The training in teaching ordinarily proceeds concurrently with the degree work throughout the three years, but a student who has passed the Intermediate Science (Agriculture) examination before admission to the College devotes the first two years to the final degree course and the third year to a post-graduate course in the theory and practice of teaching. Further particulars of the course of training can be obtained from the Tutorial Secretary of University College, Reading.

Calendar of Industrial Pioneers.

May 28, 1831. Henri Grégoire died.—Famous as an ecclesiast and a politician, Grégoire played a conspicuous part in the great events of the French Revolution, and through him the Convention sanctioned the decree of October 10, 1794, for the formation of the Conservatoire des Arts et Métiers and its installation in 1797 in the old priory of Saint-Martin-des-Champs. The Conservatoire is one of the most important scientific and industrial museums in the world.

May 29, 1864. Georg Bodmer died.—A mechanical inventor who greatly aided the progress of manufacturers, Bodmer was born in Zurich in 1786. He introduced breech-loading cannon and percussion shells, improved cotton-spinning machinery, and assisted in the construction of the Austrian railway over the Semmering.

May 31, 1831. Sir Samuel Bentham died.—Born May 11, 1757, Bentham was the elder brother of Jeremy Bentham the writer. Apprenticed to the master shipwright at Woolwich Dockyard, he studied naval architecture, and, after serving for some years under the Russian government, in 1795 was engaged by the British Admiralty to introduce machinery into the dockyards. He invented the caisson method of closing docks, designed steam dredgers, and assisted Brunel in his block-making machinery.

May 31, 1898. Sir Robert Rawlinson died.—Trained by his father, who was a builder in Lancashire, Rawlinson worked on the London and Birmingham railway under Robert Stephenson, became engineer to the Bridgewater Trust, and from 1848 to 1888 held the important post of chief engineering inspector to the Local Government Board. In 1894 he served as president of the Institution of Civil Engineers.

June 1, 1835. Thomas Charles August Dallery died.—One of the pioneers of screw propulsion, Dallery was an organ builder of Amiens. In 1803 he constructed a steam boat driven by a screw, or "escargot" as he called it, and placed it upon the Seine at Bercy. Imperfections in the machinery, which included a tubular boiler, led to the abandonment of the project.

June 2, 1891. Sir John Hawkshaw died.—A native of Leeds, where he was born in 1811, Hawkshaw gained experience on some of the northern railways and then became a consulting engineer in London. He was responsible for the stations and bridges at Cannon Street and Charing Cross, and was engineer to the East London Railway and the Great Severn Tunnel. With Brunlees he was connected with the scheme for a tunnel beneath the English Channel, and with Barlow he completed the Clifton Suspension Bridge. He was a fellow of the Royal Society and served as president of the Institution of Civil Engineers and of the British Association.

June 2, 1895. George W. Brown died.—Known in America as "the father of the corn planter," Brown was born in New York State, October 29, 1815. He began life as a farmer, then became a carpenter and assisted in the building of the second railway in New York. He brought out his first corn planter in 1851, and by 1866 there were 3000 in use. The invention and development of the corn planter was largely responsible for the prosperity of the middle west of America.

June 2, 1910. Edward Locher-Freuler died.—A celebrated Swiss engineer, Locher erected factories, water works, railway bridges, and power stations, and in middle life joined the firm of Brandt, Brandan and Co. With his partners he was responsible for the construction under the Alps of the Simplon Tunnel, 12½ miles long, which was opened on June 1, 1906.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, May 11.—Sir Charles Sherrington, president, in the chair.—Lord **Rayleigh**: (1) A photographic spectrum of the aurora of May 13-15, 1921, and laboratory studies in connection with it. A photographed spectrum of the aurora on the night of May 14, 1921, shows the negative bands of nitrogen in detail, and the green aurora line which, however, is subordinate. With atomic ray excitation of nitrogen in the laboratory, and better, in the narrow positive column (capillary tube) at low pressure, the development of the negative bands can be imitated, but other nitrogen spectra (line spectrum and second positive band spectrum) persistently appear in addition. The cathode ray spectrum is free from the latter, but the negative bands produced are not developed like those in the aurora, the intensity being much more concentrated in the first band of each group. Hard and soft cathode rays behave alike in this respect. Assuming that helium is the main constituent of the atmosphere above 130 kilom., as the theory of diffusion indicates, then it is difficult, on the hypothesis of positive ray excitation, to explain its absence from the spectrum of this particular aurora, which at Christiania reached to 470 kilom. Experiments on artificial mixtures indicate that it should be visible. With cathode ray excitation, this difficulty would be lessened, but the different development of the nitrogen bands remains.—(2) A study of the presence or absence of nitrogen bands in the auroral spectrum. Spectra of the "Northern Lights" taken in Shetland are compared with spectra of the ordinary night sky at Terling near London. Most of the Shetland spectra show nitrogen bands. None of the ordinary Terling spectra show these bands, though, owing to the long exposure given, the Terling plates show the green aurora line as strongly, or more strongly, than the Shetland spectra. On the occasion of the great magnetic storm and world-wide auroral display of May 13-14, the nitrogen bands were strongly developed at Terling.—C. **Chree**: The 27-day period (interval) in terrestrial magnetism. There is a tendency in terrestrial magnetism for disturbance to follow disturbance, and calm to follow calm, after an interval which does not depart much from 27 days. The absolute daily range of declination at Kew Observatory from 1858 to 1900 and the international "character" figures from 1906 to 1920 both show the phenomenon. Generally, it is more clearly exhibited in years when sun spots are few in number or are situated in low solar latitudes. The season of the year seems to have little, if any, influence.—M. **Barker**: On the use of very small Pitot tubes for measuring wind velocity. The finite pressure in a one-sided Pitot tube for infinitely small openings is comparable with that at the nose of a sphere, of diameter equal to the breadth of the opening, placed in a stream moving with a velocity equal to that at the centre of the pitot opening. This indicates a breakdown in the $p=\frac{1}{2}\rho v^2$ law for Pitot tubes, when the dimensions of the pitot are very small or the velocity very low, ρ being the density and v the velocity of the fluid and p the pressure difference. The value of rv/ν below which the $\frac{1}{2}\rho v^2$ law ceases to hold, r being the radius of the circular Pitot tube and ν the kinematical viscosity of the fluid, has been determined. For values of $rv/\nu<30$, $p/\rho v^2$ is greater than $\frac{1}{2}$; below this value there is a viscosity effect in the form of an additional pressure comparable, as before, with that at the nose of a certain sphere.—E. T. **Paris**: On doubly resonated hot-wire microphones. The properties of

double resonators for use with hot-wire microphones in order to increase sensitivity and also, if desired, to widen the range of response were investigated. Two types of resonator were dealt with: (a) The "Boys double resonator," consisting of a "stopped pipe" in series with a Helmholtz resonator; and (b) the "Helmholtz double resonator," consisting of two Helmholtz resonators in series.—J. C. **McLennan** and D. S. **Ainslie**: On the structure of the line $\lambda = 6708$ Å of the isotopes of lithium. A vacuum arc in the vapour of the metal together with Lummer plates and a 30-plate échelon grating crossed with a Lummer plate to effect the resolution were used. With strong arcs, $\lambda = 6708$ Å consists of two doublets, with a separation of the doublet components of 0·128 Å and 0·165 Å respectively. The mean displacement of the two doublets is 0·32 Å, which is 3·4 times that demanded on Bohr's theory for isotopes of lithium having atomic weights 6 and 7. Merton and also Aronberg in studying $\lambda = 4058$ Å, in the spectrum of ordinary lead, and in that of lead having a radio-active origin, found that the observed difference in wave-length was between 80 and 90 times as great as the difference to be expected from Bohr's theory. With both lead and lithium, in what would appear to be isotopic spectral displacements, the value found by observation is about the atomic number times the value obtained by calculation on the basis of Bohr's theory.

Zoological Society, April 25.—Sir S. F. Harmer, vice-president, in the chair.—A. **Loveridge**: Lions at their kill.—R. J. **Ortlepp**: A new species of the nematode genus Œsophagostomum from the rodent *Xerus setosus*.—R. **Broom**: On the persistence of the mesopterygoid in certain reptilian skulls.—C. F. **Sonntag**: On the anatomy of the drill (*Mandrillus leucophæus*).—A. **Loveridge**: New reptiles from Tanganyika Territory.—Miss L. E. **Cheesman**: Observations on the land-crab, *Cardisoma armatum*, with especial regard to the sense organs.

May 9.—Dr. A. Smith Woodward, vice-president, in the chair.—C. F. **Sonntag**: The comparative anatomy of the tongues of the Mammalia.—VII. Cetacea, Sirenia, and Ungulata.—D. W. **Devanesen**: Notes on the anatomy of *Cacopus systoma*, an Indian toad of the family Engystomatidæ.—E. A. **Elliott**: Monograph on the family of the Stephanidæ (Hymenoptera).

Linnean Society, May 4.—Dr. A. Smith Woodward, president, in the chair.—H. **Downes**: A relic of Henry Lyte's library. The volume consists of two works of Antoine Mizauld, the French Physician (1520–1578), "Alexikerus" and "Nova et Mira Artificia," bound together (Paris, 1564). It contains Henry Lyte's autograph, and various notes. At the end of the volume are two pages of MS. notes, mostly medical definitions or short descriptions of diseases. Henry Lyte was the translator of Dodoen's Herbal, the first edition of the translation being dated 1578. He was a member of the ancient family of Lyte of Lytes Cary, in Somersetshire, and according to Pulteney he became a student of Oxford in 1546.—J. Lloyd **Williams**: The life-histories of Laminaria and Chorda. Two kinds of gametophytes, producing eggs and antherozoids respectively, exist in the Laminariaceæ. Cultures of Laminaria three weeks old, and of Chorda three or four months old, almost invariably show the presence of two kinds of multicellular germlings, one large celled, the other consisting of cells many times smaller. The liberation of the sexual cells and the process of fertilisation have now been observed. Drew's observation of the sexual nature of the "Zoospores" was incorrect. The organisms described by him could not have been the zoospores of Laminaria, but must have been colourless monads. The Laminariaceæ thus show distinct alternation of generations: the plant is the sporophyte; reduction of chromosomes takes place in the sporangium; there are two kinds of gametophytes—a male and a female—and the difference in size between the generations is exceedingly great. The sporophyte may be gigantic, as compared with other algæ, whereas the gametophyte is microscopically small.

Royal Anthropological Institute, May 9.—Dr. W. H. R. Rivers, president, in the chair.—Capt. M. W. **Hilton-Simpson**: Ethnographical researches among the Berbers of the Aures Mountains in South-East Algeria. Physical features make the Aures massif a cultural island, in which there are many instances of the survival of ancient crafts among the Shawía, as these Berber tribes are termed. A method of manufacturing olive oil, the existing system of corn milling, and perhaps, the "waterclock" for measuring times of irrigation, evidently crept into the massif in Roman times, to remain unaltered to this day. Some arts are much older still, as witness the wheelless manufacture of pottery, which probably dates back to about 900 B.C. Being accompanied by his wife, the author was able to observe in detail the occupations of the women. Their weaving is of a very archaic kind. Traces of pre-Islamic cults can still be observed among the Shawía which, though individually slight, seem to point to a survival of the worship of a great goddess of motherhood and fertility.

DUBLIN.

Royal Irish Academy, May 8.—Prof. Sydney Young, president, in the chair.—H. H. **Poole**: Isotopes. An account was given of the discovery of the existence of isotopes among the radioactive and later among non-radioactive elements. The bearing of these discoveries on our views as to the nature of the atom was described, and the vast store of energy implied by the deviation of hydrogen from the whole number rule was mentioned as a possible future source for human use, and as a source of solar radiation.

PARIS.

Academy of Sciences, March 1.—M. Emile Bertin in the chair.—P. **Painlevé**: The classical and the Einstein theory of gravitation. A statement of the postulates of the classical theory of mechanics and of the modifications implied in the Einstein theory.—G. **Mittag-Leffler**: Gauchy's theorem on the integral of a function between imaginary limits.—J. **Andrade**: The mechanical problems of regulating springs in chronometry.—P. **Vuillemin**: Relations between the chlamydospores and the mycelian loops.—E. O. **Lovett**: The generalisation of a problem of Sophus Lie in the geometry of contact transformations.—A. **Séguin**: An automatic multiplying machine.—J. **Chazy**: The astronomical verifications of the theory of relativity. The following consequences are deduced: If the radius of the universe, supposed cylindrical or spherical, is of an order greater than 1000 years of light, the correction discussed in this note of the longitudes of the planetary perhelia is impossible to observe, but if the radius is of the order of 1000 years of light, the correction considered is nearly comparable with the actual observations, but it is impossible that the radius should be of the order of 100 years of light or less.—J. **Trousset**: The laws of Kepler and the relativist orbits. The deviation between the Einstein and Kepler orbits is of the order of one kilometre, and this, at the planetary

distances, is seen from the earth at an angle of one-millionth of a second of arc.—M. **Painlevé**: Remarks on the two preceding communications.—P. **Fatou**: The movement of a planet in a resisting medium.—G. **Guillaumin**: The equilibrium of a talus in coherent earth.—P. **Dienes**: The connection of the tensorial field.—M. St. **Procopiu**: An electro- and magneto-optical effect in liquids holding metallic powders in suspension. All liquids containing fine metallic powders in suspension show negative double refraction both in a magnetic and in an electric field. Thus double refraction does not disappear at once when the field is suppressed; there is a lag of about three minutes, except in the case of mercury, in which the double refraction disappears almost instantaneously.—E. E. **Blaise** and Mlle. **Montagne**: The action of thionyl chloride on the α-acid alcohols. Thionyl chloride and glycollic acid give two main products: chloracetyl-glycollic chloride, $CH_2Cl.CO.O.CH_2.COCl$, and the chlorosulphite, $Cl.SO.O.CH_2.COCl$. The latter decomposes readily on heating into sulphur dioxide and chloracetyl chloride.—E. **Grandmougin**: The quindolines.—C. **Deguide** and P. **Baud**: A new method for the industrial manufacture of baryta for the treatment of sugar molasses. Barium carbonate and silica, both in a very fine state of division, are heated together at a temperature of 1300° C. Subsequent lixiviation with water gave from 78 to 81 per cent. of barium hydrate, $Ba(OH)_2.8H_2O$.—L. **Semichon**: The composition of wine lees.—L. **Royer**: The inversion of the rotatory power in anisotropic liquids.—H. **Joly**: The presence of transported scales or fragments in the Celtiberic chain. (Provinces of Saragossa, Logrono, and Soria, Spain.)—P. **Russo**: The geological constitution of the territory of the Hauts Plateaux and of Figuig (eastern Morocco).—H. **Lagotala**: The chronology of the Quaternary and the Cotencher excavations.—C. **Corroy**: The Neocomian and Albian reptiles of the Paris basin.—P. **Bugnon**: The bifurcated ramification in the cotyledons.—R. **Souèges**: The embryogeny of the Rosaceæ. The last stages of the development of the embryo in *Geum urbanum*.—A. **Labbé**: The *rôle* of the alkalinity of sea water in heterogeneous impregnations.—W. R. **Thompson**: Theory of the action of insect-destroying parasites. The mathematical formulæ of cyclic parasitism.—L. **Mercier** and R. **Poisson**: *Haplosporidium Caulleryi*, a parasite of *Nereilepas fucata*.

BRUSSELS.

Royal Academy of Sciences, May 2.—M. A. Lameere in the chair.—Cl. **Servais**: The geometry of the tetrahedron (V.).—Th. **De Donder**: On the theorem of Nernst.—L. **Godeaux**: On the rational correspondences between two surfaces of one kind.—G. **Fournier** and P. **Pruvost**: Discovery of a new fish in the black marble of Denée.—D. **Tits**: The exciting factors for germination in a fungus, *Phycomyces nitens*.

Official Publications Received.

Catalogue of 1068 "Intermediate" Stars situated between 51° and 65° South Declination for the Equinox 1900: From Observations made at the Sydney Observatory, New South Wales, Australia, during the Years 1918–1919. By Prof. W. E. Cooke. Pp. vii+29. (Sydney: W. A. Gullick.)

Stonyhurst College Observatory. Results of Geophysical and Solar Observations, 1921: With Reports and Notes of the Director, Rev. A. L. Cortie. Pp. xv+45. (Blackburn.)

Carnegie Institution of Washington. Annual Report of the Director of the Department of Botanical Research. (Extracted from Year Book No. 20 for the Year 1921.) Pp. 43-75. (Washington.)

Colony and Protectorate of Kenya. Annual Report of the Forest Department, 1920–21. Pp. 15. (Nairobi.) 50 cents.

Ministry of Public Works, Egypt. Zoological Service (Publication No. 35). Report on the Zoological Service for the Year 1921, in which is included the 23rd Annual Report of the Giza Zoological Gardens. By Major S. S. Flower. Pp. ii-18. (Cairo: Government Publications Office.) P.T. 5; 1s.

Diary of Societies.

FRIDAY, MAY 26.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Thomas W. Arnold: Indian Painting and Muhammadan Culture (Sir George Birdwood Memorial Lecture).

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Dr. F. W. Aston: Atomic Weights and Isotopes (Lecture).

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section) (Annual General Meeting), at 5.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—J. C. Rennie: Engineering Appointments and how to get them.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. R. Dudfield: Reforms needed in the Notification of Tuberculosis.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. E. Dalby: The Internal Combustion Engine: Its Influence and its Problems.

SATURDAY, MAY 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Hugh Allen: Early Keyboard Music (1).

MONDAY, MAY 29.

ROYAL GEOGRAPHICAL SOCIETY (Anniversary Meeting) (at Æolian Hall), at 5.30.—Presentation of Royal Medals and other awards; Presidential Address; Annual Report; Election of Officers and Council.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—W. Harvey: Colour in Architecture.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Institution of Mechanical Engineers), at 8.—Sir George Beilby: Structure of Coke: Its Origin and Development.

TUESDAY, MAY 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Percy Sykes: Twenty-five Years' Travel in Persia.

ROYAL PHOTOGRAPHIC SOCIETY (Lantern Meeting), at 7.—E. J. Bedford: Wild Flowers.

FELLOWSHIP OF MEDICINE (at Royal Society of Medicine), at 5.—Sir W. Arbuthnot Lane, Bart.: Fractures.

WEDNESDAY, MAY 31.

ROYAL SOCIETY OF ARTS, at 3.—L. Haward: The Manchester Art Gallery and the Problem of Provincial Collections.

THURSDAY, JUNE 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Very Rev. Dean Inge: Theocracy (2). The Mediæval Idea.

ROYAL SOCIETY, at 4.30.—Prof. T. H. Morgan: The Mechanism of Heredity (Croonian Lecture).

LINNEAN SOCIETY OF LONDON, at 5.—Prof. A. C. Seward: Hooker Lecture.

JUNIOR INSTITUTION OF ENGINEERS (at Institution of Electrical Engineers), at 7.30.—Sir Eric Geddes: Fourth Canet Lecture

CHEMICAL SOCIETY, at 8.—J. S. Buck and I. M. Heilbron: The Reactivity of Doubly-conjugated Unsaturated Ketones. Part III. Unsymmetrical Hydroxy- and Methoxy-derivatives.—J. S. Buck and I. M. Heilbron: Phanopyryllium Salts of Distyryl Ketones. Part I.

FRIDAY, JUNE 2.

DIESEL ENGINE USERS' ASSOCIATION (at Institution of Electrical Engineers).—H. F. P. Purday: Marine Diesel Engines.

SATURDAY, JUNE 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Hugh Allen: Early Keyboard Music (2).

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

FRIDAY, MAY 26.

BIRKBECK COLLEGE, at 6.—Dr. E. J. Russell: Recent Work with regard to the Influence of Soil Conditions on Agriculture (3).

MONDAY, MAY 29.

UNIVERSITY COLLEGE, at 5.—A. T. Walmisley: Groynes and Sea Defence Works.

TUESDAY, MAY 30.

KING'S COLLEGE, at 5.30.—C. E. M. Joad: Vitalism Restated (1). The Reduction of Ethics to Psychology.—Dr. D. Subotić: Influence of Geography on the Economic Conditions of Jugo-Slavia (1).

WEDNESDAY, MAY 31.

KING'S COLLEGE, at 5.—Dr. A. Harker: Tertiary Igneous Action in Britain (3).

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. J. Babinski: Des Reflexes de Défense. (In French.)

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. R. A. Nicholson: The Idea of Personality in Sufism (3).

UNIVERSITY COLLEGE, at 5.15.—Dr. D. H. Scott: The Early History of the Land Flora (6);—at 6.30.—Miss Mildred Swannell: Individual Work and Dr. Montessori.

THURSDAY, JUNE 1.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Sir A. Cruickshank Houston: The Purification of Water.

SATURDAY, JUNE 3, 1922.

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British Fine Chemicals.

DURING the period of twenty years preceding the war, it was a frequent complaint among organic chemists that there did not exist in this country a firm resembling Kahlbaum or Schuchardt, from which it would be possible to obtain, at short notice, large or small quantities of those organic compounds, both common and obscure, required for the prosecution of research. The absence of such a domestic source of supply was deplorable for several reasons, but there was always said to be "no money in it," and various ingenious theories were necessarily devised to explain the survival of the German firms, which certainly did not remain in business on philanthropic grounds alone. The shock of war galvanised this branch of industry along with many others, and it was widely declared that the gradually increasing supply of these materials should be augmented to the volume essential for the brisk practice of research, and should be maintained on a self-supporting basis even when free communication with Germany had become restored.

Encouraged by these patriotic pronouncements, the industry in this country has grown to respectable dimensions, and it does not seem fair, now that the famine in German products is over, to withdraw support from those manufacturers who have expended money and thought in meeting a national need at a critical period. That, nevertheless, is the logical outcome of present complaints. At the moment, it is possible to buy these materials much more cheaply in Germany, but that is due principally to the depreciated mark, and should not be allowed to weigh with those who have permanent national interests at heart. Moreover, comparison of current British and German prices is not the test which should be applied. It is more just and reasonable to compare current British prices with those of German materials prevailing in this country before the war. On this basis we have taken at random fifty typical substances and have found that in fifteen cases the present British quotations are lower. Furthermore, dividing the British (1922) by the German (1913) price, and averaging the factor for the fifty examples, an over-all factor of 1·4 ensues. Remembering that the corresponding factors given by the Ministry of Labour for April 1922 as compared with July 1914 are: Food 1·73, rent 1·55, clothing 2·40, fuel and light 2·15, other items 1·95, it will be seen that the foregoing factor, 1·4, is astonishingly moderate, bearing in mind the difficulties which attend the enterprise.

Another feature of the price question deserves appreciative recognition. While the Safeguarding of Industries Bill was under discussion, it was freely stated that the measure would lead to enhanced prices for the

domestic products involved. If, however, the quotations in April 1922 are compared with those in September 1921 for the same fifty typical materials it is found that, of the forty-six listed in the earlier catalogue, the price of twenty-four is unchanged, the price of twenty is reduced, whilst in two cases only has it been increased.

The question of quality obviously does not admit of discussion on a quantitative basis, but it will be recalled that even the long-established German firms were obliged to acknowledge sporadic blunders, and only the chemist who himself has never failed in preparing an organic material of the highest grade is entitled to withhold mercy, not to mention justice, from those manufacturers who have endeavoured to meet domestic requirements by covering a wide range as rapidly as possible. Surveyed generally, the British quality reaches a high standard.

Moreover, the range now offered is commendable. The organic chemist, particularly in the opening phases of an investigation, sometimes requires relatively obscure compounds in quantities of a few grams at a time, and the convenience of a British price-list comprising 2500 individual substances for use in research or analysis approaches, within a praiseworthy distance, the advantages offered by Kahlbaum and Schuchardt. There is no finality to such a list, which can receive additions when requirements are made known. Even the research chemist who has been mesmerised by the multitude and cheapness of German products, and by pre-war facilities for obtaining them must, on reflection, realise the burden which would be placed on a new industry by stocking every conceivable material, a large proportion of which would not be wanted for years to come. Finally, it should be represented that if the spell of German chemical superiority is ever to be broken, one factor in its dispersal is the demonstration, to successive relays of native students, that it is possible to produce in this country chemical materials of good quality and at reasonable prices. Moderate self-denial and exercise of fair-play during the next few years appear to be the principal equipment required in achieving this most desirable end.

M. O. F.

Northernmost Greenland.

Greenland by the Polar Sea: The Story of the Thule Expedition from Melville Bay to Cape Morris Jesup. By Knud Rasmussen. Translated from the Danish by A. and R. Kenney. Pp. xxiv + 327 + pls. and maps. (London: W. Heinemann, 1921.) 36*s*. net.

MR. KNUD RASMUSSEN occupies a unique place amongst polar explorers because, as the son of a Danish pastor in Greenland, he spent the first fourteen years of his life amongst the Eskimo, knowing their language like his own and entering into their modes of life as to the manner born. There was thus nothing strange or repulsive to him in the diet, the clothing, or the housing of the Eskimo, and after his education at the University of Copenhagen, he turned to the exploration of Greenland and the study of its people as naturally as a seal takes to the water.

In 1903–4 Mr. Rasmussen sojourned as a member of the Danish Literary Expedition among the "Arctic Highlanders," first discovered by Sir John Ross in 1818 and made familiar to English readers by Peary's repeated winterings. In 1910 Rasmussen established a station named Thule on the shore of Wolstenholme Sound, nearly in 77° N., and from this centre he made his "First Thule Expedition" in 1912–13; he crossed the inland-ice to the north-east, and proved that Peary was in error when he supposed that his Independence Bay was on a channel which cut off northernmost Greenland as an island. Rasmussen's intention had been to return to Thule along the west coast of Greenland from its most northerly point, but circumstances compelled him to go back by the way he came. An attempt to repeat the journey in 1914 failed, and the purpose of the book now under review is to describe the journey northward along the west coast which was carried out in 1917. The motive of the expedition was ethnographical—the discovery of the route by which the great Eskimo migration entered Greenland, and it was only preliminary to a greater journey, not yet completed, along the north coast of America.

The range of the journey is stated on the title-page as "from Melville Bay to Cape Morris Jesup," but was really less, as De Long Fjord was its termination. None of the ground traversed on the outward journey was new in the sense of first discovery, for the whole coast had been charted from the sea by expeditions which had forced their way through Smith Sound and the channels to the polar ocean, while sledge parties from Nares' expedition onwards had skirted much of the coast.

The interest of Rasmussen's journey lies in its methods as much as in its results. He was accompanied by two Scandinavian men of science—Dr. Koch, a Danish geologist, and Dr. Wulff, a Swedish botanist. There were also four Eskimos, and when the expedition started from Thule on April 6, 1917, it had 6 sledges and 185 dogs. The expedition carried a minimum of European stores and equipment so as to travel quickly, and beyond luxuries such as cocoa, tea, sugar, prepared oats, biscuits, and pemmican, all food was to be obtained by hunting.

The first day's journey was 94 kilometres, accomplished in ten hours, a magnificent performance on the sea-ice, which was never equalled afterwards; as

the distance is inadvertently given as "94 miles," the casual reader might suspect the author of romancing; but no explorer ever recorded his exploits more modestly. In many particulars it is a little difficult to follow the narrative, for the author is frequently obscure and discursive in his general statements, and the translator has been sorely troubled by the rendering of scientific terms. The reader may indeed feel a glow of justifiable satisfaction when he reasons out that the piece of apparatus designated a "cooking barometer" must be neither more nor less than a boiling-point thermometer! Also it takes time to accustom oneself to the one word "mountain," applied equally to mean mountain, hill, or knoll.

One has not to read far, however, before the narrative grips the attention, and the difficulties of style and terminology do not disguise the fact that Rasmussen travelled with the inherited skill and resourcefulness of the Eskimo and the insight of a man of science.

A series of helpful sketch-maps for each section of the journey is provided as well as an excellent general map. The route of the expedition ran north through Smith Sound, Kane Basin, Kennedy Channel, Hall Basin, and Robeson Channel on the sea-ice or the ice-foot, closely following the Greenland coast, stopping to hunt and gorge on seals, reindeer, musk-oxen, hares, or ptarmigan where game abounded, pushing forward desperately over the barren country, where the dogs had to be fed on their weakest comrades. At length on June 21, 1917, they reached the entrance to De Long Fjord in 83° N. and faced the problem of the return. The easy travelling of spring was past. It was impossible to move quickly over the thawing sea-ice; the sledges could not be dragged across the bare, stony coastlands with their sparse growth of the brilliant Arctic flora, and it was necessary to find a way up to the distant inland ice and to lay in a store of food for the long march over the empty snow-fields. A find of 24 tins, each containing 9 lb. of New Zealand mutton, left by the Nares expedition in 1875, before any of Rasmussen's party was born, had given occasion to much feasting on the way north, for the meat was as good after 42 years as if freshly tinned. One cannot help thinking that such a windfall of portable food might have been saved for the inland-ice journey; but the Eskimo rule of unlimited feeding when food is available appears to have been faithfully carried out.

It was the end of July before the party had got back to St. George's Fjord in 82° N. with all the fresh meat they could collect, and on August 4 they succeeded in ascending the glacier at the head of the fjord on to the inland-ice, with only 17 dogs remaining. Their supplies allowed only 12 days for making the journey to Cape Agassiz, south of the Humboldt Glacier. There they hoped to replenish their food supplies by hunting. One of the Eskimos had been lost in St. George's Fjord, they were all weak, and Wulff was very ill. It was 20 days before they reached the sea in a starving condition, all the dogs having been eaten. Rasmussen, with the strongest Eskimo, left the others and hurried southward along the coast, but by the time he met the native hunters and could send back supplies, Wulff had died. It is impossible to read of the hardships all had undergone without realising that the dangers of following Eskimo practice are very nearly equal to the advantages. It was October 22, 1917, when the survivors returned to Thule.

The scientific results of the expedition were substantial, and may to some extent be gathered from the narrative and the appendices. The map has been rectified in many particulars and the outlines of several fjords laid down for the first time. The extent of the ice-free land where life is possible has also been mapped in considerable detail. This lies between the sea-ice which never leaves the coast and the inland-ice which occupies the high land of the interior. The geology has been studied, and Koch is of opinion that the folded mountain system of the extreme north of Greenland is an extension of the Caledonian fold, which curves westward from Norway through Spitsbergen and continues westward of Greenland into Grinnell Land. Some interesting notes on air temperature are also given.

Dr. Wulff left valuable notes on the flora, including the observation that flowers formed one summer survived the cold of winter and matured in the second summer. The habits of the musk-ox are further elucidated and illustrated by excellent photographs, while there are many notes on insect life, the most curious being the appearance of enormous swarms of bluebottles, which make it almost impossible to keep meat killed in summer for more than a day or two in 82° N. The most important result, however, is the light thrown on the migrations of the Eskimo. Mr. Rasmussen has satisfied himself that they came from America, passed through Ellesmere Land, crossed Smith Sound, and moved down the west coast of Greenland, round Cape Farewell, and up the east coast. He is certain that they could not have reached the east coast by the shorter route along the north coast of Peary Land, which he thinks was never inhabited, and can never support human life.

The author refers in terms of generous appreciation to his predecessors of all nationalities, and amongst the most interesting illustrations are facsimiles of the letters deposited in cairns by parties of the Nares and Greely expeditions. The English version of the book

is appropriately prefaced by an appreciation of the author's work by Sir Lewis Beaumont, who himself did heroic service in leading one of the sledge parties from the *Discovery* nearly half a century ago.

HUGH ROBERT MILL.

Modern Tendencies in Physiology.

(1) *Practical Physiological Chemistry*. By Dr. J. A. Milroy and Prof. J. H. Milroy. Third edition. Pp. ix+449+ii pls. (Edinburgh: W. Green and Sons, Ltd., 1921.) 21*s*. net.

(2) *Biological Chemistry*. By Dr. H. E. Roaf. Pp. xvi+216. (London: Methuen and Co., Ltd., 1921.) 10*s*. 6*d*. net.

(3) *An Introduction to Biophysics*. By Dr. D. Burns. Pp. xiii+435. (London: J. and A. Churchill, 1921.) 21*s*. net.

THE curricula of most universities represent Natural Science as being made up of a number of subjects: geology, mineralogy, chemistry, physics, zoology, botany, human anatomy, and physiology, astronomy being grouped rather with mathematics than with natural science. Twenty years ago such a classification represented not only the scaffold on which the standard of departmental teaching and examination was erected, but it also represented the current conception of the limits between subject and subject. Where will these limits be twenty years hence? Everywhere the boundaries are disappearing; the physicist has made far-reaching additions to the basal conceptions of chemistry, the zoologist has largely forsaken animal morphology for fatherless frogs and the inheritance of sex characteristics. Of no department of science have the boundaries become less distinct than they have of physiology. One phase of the change which is taking place is emphasised by the publication of the three books, the titles of which stand at the head of the present article.

(1) "Practical Physiological Chemistry" written jointly by Prof. J. H. and Dr. J. A. Milroy, has already had a long and honourable career, and is now in its third edition. It represents the first phase in the change—that in which organic chemistry commenced to play a prominent part in physiology. In the present edition considerable additions have been made, especially in the direction of physical chemistry, but the book essentially stands for what it always did, namely, for physiology seen from the angle of the organic chemist, and as such its value is fully maintained.

(2) Dr. Roaf's book, "Biological Chemistry," represents a much more fundamental change. It deals with something wider than the mere chemical aspect of vertebrate physiology. As its title suggests, it embraces the chemical aspect of life generally, hence it includes not only invertebrate physiology, but botany in its bracket. The subject-matter of the book, therefore, covers parts of what formerly were regarded as three biological subjects, namely, physiology, zoology, and botany. It inevitably raises the question, "What are the real boundaries of physiology?" The question is a vital one in the teaching of science and medicine. Concrete instances of the transition which is taking place may be found in the organising of any medical school, and that of Cambridge may be cited as an example. Just before the war, the department of physiology was reorganised, a new laboratory was erected with much greater accommodation than the old one, yet at the same time experimental psychology and biochemistry were both recognised as new subjects and given laboratories of their own. In Manchester, where the subject of physiology has also been reorganised, the cleavage has taken place at a different point. Biochemistry remains a part of the subject, but histology has been handed over to the department of anatomy. What then remains as the essence of physiology? If it is to lose histology, experimental psychology, including a large part of the study of the organs of special sense, and biochemistry, what is to remain? What justification is there for a department of physiology at all?

In discussing this matter a couple of years ago, a well-known physiologist took up the position that what remained was biophysics. Turning then to Dr. Burns's volume (3), "An Introduction to Biophysics," it was a matter of peculiar interest to ascertain the extent to which it bore out the definition of being what remained of physiology after that subject had parted with biochemistry and experimental psychology.

Dr. Burns's book—incidentally we would remark that it is very nicely got up, being pleasant both to hold and to read—will well repay perusal, and should be read by both teachers and the more reflective class of students. The title of the book, however, seems to embrace less than the covers, but even granting that there is more in the book than is legitimately covered by the term biophysics, there still remains much of physiology which is not there.

The question then, what is left of physiology after biochemistry, biophysics, and experimental psychology have been taken from it, remains unanswered. The answer in our view is simply this—physiology remains. Biochemistry and biophysics are the apparatus of physiology, but they are not physiology. To the physiologist they are all-important, for to him every advance which is made in biochemistry is vital, because it gives him a new machine with which to explore his own department of knowledge.

To take a concrete example, nothing could be more truly in the domains of biochemistry and biophysics than are the chemical and physical properties of hæmoglobin. When our knowledge of these properties is complete—and it is now only commencing to open up—we shall be but in a position to commence the study of the red corpuscle—its birth, its fate, the extent to which it may be regarded as a living entity, and its relationship to other tissues in the body. These are physiology—physiology surely remains; and indeed these reflections apply not only to physiology but to pathology and medicine. It is only a matter of time till corresponding books on these subjects appear. There are chemical and physical aspects of pathology and medicine as truly as of physiology, but when pathological chemistry and the chemistry of medicine have said all that they should say, they too will be rather the necessary apparatus of pathology and medicine than the subjects themselves. Pathology and medicine will consist in the application of the chemical facts to the human subject as a whole—jointly with many other kinds of facts which are not chemical.

In the future of medical schools it would look as though chemistry and physics would be taught all along the line by persons specially qualified for the task, not merely as at present for the first M.B., or as in some cases organic chemistry for the second M.B. is now taught, not as side issues or luxuries or as the affairs of specialists, but as the necessary groundwork from which medical science grows—soil necessary to the tree. The line between the ground and the tree may be artificial and may be movable, but the distinction between the ground and the tree does not lack reality on that account.

Early Chinese Pottery.

The Early Ceramic Wares of China. By A. L. Hetherington. Pp. xviii + 160 + 44 plates. (London: Benn Bros., Ltd., 1922.) *3l. 3s.* net.

THIS excellent and trustworthy piece of work, obviously the fruit of prolonged research and consideration of the available evidence, is precisely the book one would recommend to the student or collector who was about to enter upon a serious study of the earlier Chinese pottery and porcelain with a view of forming a collection for his personal delight and study; for it is conceived and carried through in such a fine vein of reasoned enthusiasm that one could scarcely wish for a saner yet more inspiriting guide. Though our knowledge and understanding of the progressive steps by which the early pottery and porcelain of that vast territory were slowly brought to perfection are still incomplete, and must probably always remain so, really competent works such as this are of great value, if further progress is to be made in the task of elucidation, because they focus attention so clearly on what is known and, at the same time, remind us of the most important points that are still unknown or, at best, imperfectly understood.

European knowledge of the earlier centuries of Chinese ceramic history is a plant of slow and comparatively recent growth. There is all the more reason, therefore, to welcome a volume of this scope and style—illustrated by an abundance of choice examples which have been carefully selected from the most famous English collections, especially from those which are still in private keeping—which describes, in a connected narrative with copious references to the standard authorities, those delightful and alluring examples of the potter's skill which are anterior in date (many of them long anterior), to the foundation of that important masterful dynasty known as "The Ming" (the chiefs of a western warrior race which seized the Imperial throne in A.D. 1368, and held it in the most brilliant fashion for close on three hundred years).

Although the Chinese potters of Sung times, under their native rulers, had made an abundance of fine porcelains of superb artistic quality for some centuries before the advent of the Ming rulers and overlords, it was only during the sway of the latter that the mysterious substance, Chinese porcelain, found its way into the treasure-cabinets of European princes in any appreciable quantity. For centuries after its first sporadic appearance in Europe, the novelty of its substance, together with the matchless skill displayed in its fabrication and decoration, gave rise to a crop of the wildest legends and guesses as to its nature and composition. This is especially shown in the writings of our medieval European naturalists and alchemists, who, while groping in the dark among things old and new, were laying the foundations of modern scientific methods and knowledge. The era that saw the Ming emperors firmly seated on the throne of China was of great moment in the history of civilisation, for all over the old world a spirit of keen intellectual activity and enterprise worked like a new leaven, manifesting itself in eager inquiry into all the things of heaven and earth no less than in the accomplished production of fine material things. It seems like one of nature's own revenges that a period of time which was once a chosen domain for the historians of the drum and trumpet school is now seen to have been pregnant with discoveries and inventions which were to revolutionise the subsequent progress and prospects of mankind.

In a work of this class the reader will always consider

the sources to which an author attaches most weight, and here Mr. Hetherington proves himself at once catholic and discriminating. The older European authorities like Dr. Bushell, Sir A. Wollaston Franks, and his successors in the famous school of the British Museum have naturally been used to great advantage, while the writings of Mr. Berthold Laufer and other special workers in the history of early Chinese art have been drawn upon with discrimination. One would say off-hand that no modern opinion of value has been overlooked, while each, in turn, is supported or refuted from authoritative sources. This piece of patient toil has been carried out with much discrimination, as is especially manifest in the author's appraisement of the information that is to be obtained only from Chinese sources. The valuable original sources are set out in a select bibliography, where a list of the most important English and French works on the subject is also given.

The illustrations of the ancient wares, gathered from many sources, are worthy of the book and really illustrate it, while they have been chosen in a truly commendable way. Mr. Hetherington explains the manner of his choice in a few words which deserve to be quoted: "In selecting the illustrations I have followed a somewhat unusual course. The specimens chosen are not the rarest and most costly examples, nor are they taken from the great National Museums. I have illustrated typical pieces of good quality in the possession of private collectors. The ordinary person, in my opinion, wants to see the kind of thing he may hope to acquire for himself; not specimens worth a king's ransom which are never likely to adorn his cabinet."

WILLIAM BURTON.

Optical Theories.

(1) *Die Prinzipien der physikalischen Optik. Historisch und erkenntnispsychologisch entwickelt.* Von Ernst Mach. Pp. x+444. (Leipzig: J. A. Barth, 1921.) 48 marks.

(2) *Optical Theories: Based on Lectures delivered before the Calcutta University.* By Prof. D. N. Mallik. Second edition, revised. Pp. vii+202. (Cambridge: At the University Press, 1921.) 16*s*. net.

(1) ERNST MACH died in February 1917, at a time when civilised humanity was too busy to notice the passing of one who had made his influence felt wherever interest existed for the understanding of the fundamentals of mechanical and physical knowledge. The present work was published in 1921, but it is not a posthumous work, for it was ready before the war, and in fact the preface is dated July 1913. Although it went to press in 1916, the war and other causes delayed its issue.

As the title indicates, the book is an historical and epistemological account of the development of the principles of physical optics, the writer's aim being similar to that in his famous book on Mechanics. The book is thus not really a history, but rather a statement of the progress of ideas and of the manner in which they arose in the minds of their originators. Nobody who has read other books by Mach will need to be told that this volume is interesting and instructive: the description of the way in which the fundamental notions such as periodicity and asymmetry of the light ray emerged, is as fascinating as any romance.

The present volume was intended as a first part of a larger work: subjects like theories of the ether and relativity were reserved for the second volume. But the author's foreboding that this second volume would not be written by himself was unhappily justified.

Many points of interest emerge in the course of this history. Full tribute is paid to Newton's genius—it was Newton who first realised clearly the periodic nature of the light ray, later worked up into the wave theory, and its asymmetry, which became the theory of polarisation and the notion of the transverse light-vector. When Fresnel first reached the conclusion that light oscillations are transverse, the revolution in ideas was too great for even Arago, who refused to be associated with Fresnel's idea, and in fact, although Fresnel and Arago collaborated in many pieces of work, the transverse vibration theory was put forward in a paper bearing only Fresnel's name. Young's experiments did not at once receive the recognition they deserved, owing to the mistaken and reactionary servitude to all that was supposed to have emanated from Newton. The author has not much good to say about Schopenhauer's attempt at a theory of colours, while faint praise is all that is allotted to Goethe.

As already remarked, relativity as such is not discussed in this book, and even when Michelson's interferometer is described nothing is said about the 1887 experiment. Nevertheless the author felt it incumbent upon him to decline the honour of having been the herald (*Wegbereiter*) of relativity. On various grounds he refuses to accept the theory—presumably this refers to the restricted theory—and, while acknowledging the value of the relativist researches, he doubts whether the theory itself will find a lasting place in the physical *Weltbild* of the future. Mach asks: "Will the theory of relativity be more than an ingenious *aperçu* in the history of this science?" Would Mach's opinion have been affected by the events of 1919?

(2) The lectures delivered by Prof. Mallik at Calcutta in 1912 were published in book form in 1917, and the

book has been reissued in a second edition. It offers a brief technical *résumé* of the optical theories since Descartes and Fermat till the present day, a little being also said about ancient European and Indian ideas on the subject. The elastic solid theories, the electromagnetic theory, and the electron theory are passed in review, each treated briefly in mathematical manner, with its virtues and its imperfections exposed. In the second edition there are a few additions, notably on the theory of relativity in so far as it affects optics, and the opinion is expressed that this theory will not "dispose of the physical existence of the *etherial model*, until a better one can be found, which shall explain the intimate nature of the various concepts of modern physics, corpuscles and negative particles, electric charge and magnetic force, gross matter and gravitation, in one comprehensive scheme."

S. BRODETSKY.

Notes on Inorganic Chemistry.

Notes on Inorganic Chemistry for First Year University Students. By Prof. F. Francis. Pp. viii + 244. (Bristol: J. W. Arrowsmith, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1921.) 8*s.* 6*d.* net.

THE reputation which Prof. Francis has gained as a teacher is so firmly established that a book written by him on the lines that he has adopted for his lectures may be expected to be of much interest and value. Although the "Notes" have been written primarily for students of Bristol University they will, no doubt, be found useful by many others.

The book commences with a few interesting extracts of a philosophical nature from the works of various authors and a brief note on the indestructibility of matter; the subject of errors is then fully discussed, and the laws relating to gases are considered at length. The properties of hydrogen and oxygen are next described together with those methods of preparation which are of practical or theoretical importance. Opportunity is thus afforded for reference to catalysis, autoxidation, and the methods of determining the relative atomic weights of these two elements. The next three chapters are devoted to a discussion of the chemical atom, energy, thermochemistry, and to a fuller account of catalysis. In the chapters on the physical properties of water, a variety of subjects are discussed, such as vapour pressures and boiling points, the phase rule, solutions, osmotic pressure, electrolysis, dissociation, and the electron theory. The utilisation of atmospheric nitrogen in the preparation of ammonia and nitric acid is considered in some detail and the natural sources of these substances are mentioned. Reference to the action of sulphuretted hydrogen on arsenious acid serves as an introduction to a brief discussion of the chemistry of colloids, and in the remaining chapters Dulong and Petit's law, the periodic law, the laws of constant composition and of multiple proportions, the law of isomorphism, and the subject of valency are discussed.

The book is for the most part very clearly written, but typographical errors are rather numerous: for example (p. 9), $3{\cdot}1415^{10} = 93{,}621$, not $93{\cdot}621$; (p. 21) ρ' should read ρ; (p. 36) for Nitrogemn read Nitrogen; (p. 44) Lavoisier's name appears in place of Scheele's; (p. 56) for "proportional now" read "proportional. Now"; (p. 97) ·62%, etc., should be 62%, etc.; (p. 110) for Ladenberg read Ladenburg; (p. 179) for $HClO_4$ read $HClO_3$; (p. 205) the formulæ for apatite and vanadinite require correction; (p. 207) in the italicised sentence, "of" should read "or" and "methods" should read "molecule"; (p. 226) the constant m does not appear in the formula.

No doubt these mistakes will be corrected when a second edition is required.

There are a few statements which appear to be open to objection: On p. 23 Dalton's law of Partial Pressures is stated thus: "If P = total pressure and V = total volume,

$$P = p_1 + p_2 + p_3 \ldots;$$
$$V = v_1 + v_2 + v_3 \ldots\text{"}$$

It is not stated, however, that the second equality only holds if the volumes are all calculated at pressure P.

In the thermochemical equations on p. 57 it would perhaps be better to write $\frac{1}{2}H_2$ rather than H where molecular and not atomic hydrogen is meant.

On p. 65 there is the statement that "at 0° C. and 4 mm. pressure, Ice $\rightleftharpoons$ Water $\leftarrow$ Vapour." Presumably "$\rightleftharpoons$ Vapour" is intended, but, in any case, the triple point pressure of water is 4·6 mm., and at 0° C. and 4 mm. pressure water could only exist as vapour. A correct statement would be: "at 0·0075° and 4·6 mm. pressure

$$\text{Ice} \begin{array}{l} \rightleftharpoons \text{Water} \\ \quad\;\; \upharpoonleft\!\downharpoonright \\ \rightleftharpoons \text{Vapour.} \end{array}$$

It is stated on p. 88 that "one gm. molecular weight of Methyl Alcohol, 32·03 gms., dissolved in 1000 gm. of water raises the Boiling Point to 100°·52"; but, of course, all mixtures of methyl alcohol and water boil at a lower temperature than pure water. It is evidently assumed that methyl alcohol is practically non-volatile.

The following sentence occurs on p. 204: "atomic weight of Sulphur: atomic weight of Selenium = 18·39 : 45·34 of Sulphur = 32." Presumably the words "of Sulphur = 32" should be deleted. There is also a

discrepancy between the value 45·34 and that (45·40) given previously as the weight of selenium equivalent to 18·39 of sulphur.

Students who read this book carefully in conjunction with their lectures and laboratory work will be in a position to continue their studies in theoretical and practical chemistry with great advantage.

The Origins of Disease.

Organic Dependence and Disease: Their Origin and Significance. By Dr. J. M. Clarke. Pp. 113. (New Haven: Yale University Press; London: Oxford University Press, 1921.) 12*s*. 6*d*. net.

THE distinguished palæontologist who directs the New York State Museum at Albany has here brought together a number of instances of dependent life, tending to or attaining a parasitic habit, as presented by fossils mostly of palæozoic age. Some of these have long been known, others are due to Dr. Clarke's own skilled observation, but it is useful to have them all assembled. On this foundation is reared an edifice of philosophic conclusions, imposing in its dimensions and decorated with much verbal ornament. But, as in all great architecture, the main lines of the structure are few and simple, nor do they diverge unduly from accepted tradition. "Disease is any departure from normal living." "Normal living means full activity of an unimpaired physiology inclusive of the function of locomotion or mobility." Those who consider the lilies of the field will protest that these definitions are scarcely traditional. True; but, if they be accepted as interpretations of terminology, the actual theses will not appear so revolutionary.

The main conclusions are these. Among animals, at any rate, evolutionary progress has been always through those races that have retained full powers of locomotion. The assumption of a stationary mode of life is a step on the primrose path, and that one false step is ne'er retrieved. (Clearly Dr. Clarke does not believe in the fixed ancestor of the echinoderms.) The proportion of forms that retained their freedom was greater in the earliest known faunas. These statements are even more applicable to animals that have adopted a life of dependence on others. Simple association precedes either symbiosis or parasitism, and the evolution of a parasitic habit was gradual, extending it may be through many geological periods. This is well exemplified by the history of those simple sea-snails that took up their quarters near the vent of a certain species of crinoid and subsisted on the issuing stream—a history traced from Ordovician to Middle Carboniferous times. In treating of the oldest faunas, Dr. Clarke perhaps trusts too much to negative evidence, but his main lines of argument are reasonable enough.

It is of the host we speak as suffering from disease; but the parasite also lives a life that Dr. Clarke calls "abnormal" or even "unrighteous." Neither sin nor disease was "original" with life as a whole. Even the bacterium of the Precambrian was a free and independent organism. As for man, "it is safe to say that none of his physical ancestors have ever surrendered their physical independence or suffered essential modification through perturbation of their normal activities." Holding such views, Dr. Clarke naturally does not sympathise with some recent attempts to base evolution on pathology. He does not agree, for example, with Eccles that "The path of evolution is the path of past disease." He might, however, have discussed the further philosophical (or theological) question, whether sin and disease in a part of creation may not be a necessary condition for the evolution and salvation of the other part. Such lofty subjects may seem remote from the humble invertebrates of palæozoic seas, but Dr. Clarke is justified in his claim that a study of life-relations in their simple beginnings may furnish clues to our own social and psychic problems.

Shallow-water Foraminifera.

Department of Marine Biology of the Carnegie Institution of Washington. Vol. xvii.: *Shallow-water Foraminifera of the Tortugas Region.* By Joseph A. Cushman. (Publication 311.) Pp. 85+14 plates. (Washington: Carnegie Institution, 1922.)

IT is no disparagement of the excellent work which Dr. Cushman has already done to say that his report on the "Shallow-water Foraminifera of the Tortugas Region" marks a significant step in advance. We do not agree with his practice of reviving obsolete generic names, such as Discorbis, Quinqueloculina, and Triloculina; the first has long been abandoned in favour of Discorbina, and the two latter have become merged in Miliolina. It appears to be undesirable to complicate synonymies by the revival of early names. But, after all, this divergence of opinion is a minor point which, however confusing to the novice, in no way detracts from the value of Dr. Cushman's work to the advanced student.

The memoir is well worthy of its place amid the zoological literature published by the Carnegie Institution of Washington, and its value is increased by a map of the region, some excellent figures in the text, and fourteen plates which compare favourably with the illustrations of some of the author's earlier works, their enhanced value lying in the fact that they are original drawings "*ad nat.*," and not

mere *clichés*. The introduction contains valuable observations on living species, an addition to the scanty literature of this subject which has real interest. Dr. Cushman here directs attention to the protective coloration of a small crab which has reddish spots of the same colour as *Homotrema rubrum* (Lamarck), the remainder of its carapace and legs being of the same colour as the dead coral with which both the crab and Homotrema are associated. So far as we remember, this is the first record of a rhizopod in such a connection. There is also a short note on the colours of living Foraminifera, but this adds little to our knowledge of the subject, and we regret that Dr. Cushman, with the facilities at his disposal, has not gone more deeply into this question, especially as regards Homotrema, *Globigerina rubra*, and *Truncatulina rosea*.

Space does not permit us to discuss many interesting points raised by the author, but his observations are always temperate and demanding attention. We cannot, however, agree with his suggestion that *Marsipella cylindrica*, Brady, is really a species of Haliphysema. If we have any quarrel with Dr. Cushman it is but the old feud between "lumpers" and "splitters." Dr. Cushman has an enthusiasm for the creation of new species and varieties for what in many cases appear to be merely local variations, a practice which, in our opinion, is to be deprecated as tending to increase an already intolerable state of confusion. There is less excuse for him than for most "splitters," as his knowledge of the literature of the order is phenomenal. In this memoir, out of 144 species and varieties recorded 23 are described as new to science, and there are 9 others previously separated by the author. Consideration being had to the existing literature of West Indian Foraminifera, we cannot help regarding the proportions as excessive.

E. H.-A.
A. E.

Our Bookshelf.

Organic Chemistry, or Chemistry of the Carbon Compounds. By Victor von Richter. Edited by Prof. R. Anschütz and Dr. R. Meerwein. Translated from the eleventh German edition by Dr. E. E. Fournier D'Albe. Vol. 2: *Chemistry of the Carbocyclic Compounds.* Pp. xvi+760. (London: Kegan Paul, Trench, Trubner and Co., Ltd., 1922.) 35*s*. net.

"RICHTER" is too well known to need description, and the only matter requiring attention is the way in which the translator has done his work. In the first place, it must be pointed out that the German edition on which the translation is based was published so long as ten years ago, and the volume for review is, therefore, relatively out of date. In the second place, a much more serious fault is the surprisingly inexact way in which the translation has been carried through. Even an elementary knowledge of chemistry and of technical German would have prevented such translations as "carbohydrate" for "Kohlenwasserstoff," and would have allowed the German names "benzol," "anilin," "hydrazin," "hydrokinone," "mono-sulpho-per-acid," etc., to have been rendered into their English equivalents. As examples of chemical errors may be mentioned the use of *ferric* sulphate as a reducing agent, MnKO as the formula of potassium permanganate, etc. These are but a few of the elementary blunders for which the translator is responsible, and as a result the book will be found very confusing by students. As a book of reference for those who already have a good knowledge of organic chemistry it will certainly be found very useful.

The Chemistry of Combustion. By Dr. J. Newton Friend. Pp. viii+110. (London: Gurney and Jackson, 1922.) 4*s*. net.

THE account given by Dr. Friend of the chemistry of combustion, including flame, ignition temperatures, and the propagation of flame in gaseous mixtures, is clear and concise and should be of interest to students. Most of the newer work, especially that of Dixon and his students, is covered, and adequate references are usually given. If one might venture a criticism of many recent monographs, including that under review, it would be that far too little attention is now paid to the experimental methods. To young students a study of the way in which practical difficulties have been faced and overcome is of much greater value than a bald abstract of the results finally won. One misses here, for example, an adequate account of the highly ingenious apparatus of Dixon for the measurement of the velocities of detonation waves (is there not a difference between "detonation" and "explosion"?), and that of Petavel and of Pier for the measurement of explosion pressures (there is not even a reference to the latter). The collected numerical data in the book are useful; a more critical treatment would perhaps have been possible only if the author had been an expert.

A Course of Instruction in Quantitative Chemical Analysis for Beginning Students: With Explanatory Notes, Questions, and Analytical Problems. By Prof. G. McP. Smith. Revised edition. Pp. x+218. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1921.) 12*s*. net.

PROF. SMITH'S book is intended for students who have completed a year's work in elementary chemistry, including qualitative analysis, and are beginning the study of quantitative analysis. In England a certain amount of volumetric analysis is usually included in the first year's course at the university, so that some of the second half of this book could be used with intermediate students. The directions are usually arranged under the headings of "Method," in which a brief but fully adequate account of the process is given; "Procedure for the Determination," in which all the needful practical details of manipulation are described, so that the work of the demonstrator may be reduced to a minimum; and, finally, "Notes," in smaller type, which give the reasons for the procedure, equations, theoretical explanations (in which physical chemical conceptions are explained and used), and

practical hints. The book, which is attractive in appearance, is the work of an experienced teacher and can be recommended with confidence.

Experimental Physiology. By Sir E. Sharpey Schafer. Third edition. Pp. viii + 131. (London: Longmans, Green and Co., 1921.) 6*s.* net.

THIS laboratory manual of experimental physiology, first published in 1912, has now reached a third edition. To those who do not know the book it may be said that the matter is arranged in thirty-two chapters, each of which contains, on the average, enough to occupy the student for a laboratory period. The book does not deal with chemical physiology; hence the amount of time demanded by a course such as the present is more than some schools will find themselves able to devote to it; a certain number of the exercises, however, are intended for advanced students, though the author does not attempt to mark these off from the rest, the selection having been left to the teacher. The author's experience is a sufficient guarantee of the suitability of the matter, and of the method of arrangement; the descriptions of the experiments, though concise, are lucid; and the book is amply illustrated by ninety explanatory figures.

Laboratory Exercises in Applied Chemistry for Students in Technical Schools and Universities. By Dr. W. Moldenhauer. Authorised translation by Dr. L. Bradshaw. Pp. xii + 236. (London: Constable and Co., Ltd., 1921.) 12*s.* 6*d.*

THE long title of this book is somewhat misleading; "Technical Chemical Analysis" would have been much more appropriate. The explanations of industrial processes which are interspersed are clear and concise, but some of the methods differ from those in common use in this country. No mention is made of the important ammonia oxidation process in describing the fixation of nitrogen. The exercises cover a wide field, including water, fuels, alkali industry, fertilisers, metals and ores, oils, fats and waxes, soap, glycerin, and lubricants. The translation appears to have been carefully done, and the book may be recommended to senior students who intend to follow industrial chemistry.

The Haunts of Life: Being Six Lectures delivered at the Royal Institution, Christmas Holidays, 1920–1921. By Prof. J. Arthur Thomson. Pp. xvi + 272 + xvi plates. (London: Andrew Melrose, Ltd., 1921.) 9*s.* net.

THE Christmas Holiday Lectures at the Royal Institution have resulted in several books that charm the general reader as thoroughly as the spoken word held the attention of the juvenile audience to which the lectures were delivered. To those already existing Prof. Thomson has added "The Haunts of Life," where, in simple language, he sketches the problems that confront the inhabitants of the waters fresh and salt, shallow and deep, open and coast-bound, of the dry land, and of the air. His brief studies of animal adaptations, and of race-migrations from one "haunt" to another, are admirable, and open to the thoughtful reader a wide field of deep philosophic interest. The book should be on the prize-book list of every school.

The Alo Man: Stories from the Congo. By Mara L. Pratt-Chadwick and L. Lamprey. (Children of the World.) Pp. 170. (London and Sydney: George G. Harrap and Co., Ltd., 1921.) 3*s.* 6*d.* net.

THE series of which the volume under notice forms a part, is designed to open for young readers the study of geography and history as living subjects. It is written as a narrative of events in the tribal life of a boy and girl in the Congo Forest, culminating in an exciting fight between the tribe and a band of Arab slave traders which ends in the discomfiture of the latter. The Alo Man, a wandering story-teller, is responsible for the introduction into the narrative of a number of folk-tales of the animal type. The book is true to detail of a generalised forest type, although both type and area might perhaps have been more precisely defined with advantage.

Alternating Currents. By G. C. Lamb. Part I. Pp. viii + 73. 5*s.* 6*d.* net. Part II. Pp. viii + 127. 7*s.* 6*d.* net. (Cambridge: At the University Press, 1921.)

IN the books under notice a full explanatory syllabus is given of the lectures delivered to third-year students in the Engineering Laboratory at Cambridge. The volumes are meant primarily to be a help to the student when writing up his lectures. They will also be useful to teachers in technical schools, as the diagrams are beautifully clear, the descriptions are good, and many of the proofs given are very neat. The notation and nomenclature are practically international. "Effective," however, is now preferred to "virtual." Personally we prefer "sine-shaped" to "sinoidal," and "not sine-shaped" to "non-sine."

The Structure of the Atom: Notes on some Recent Theories. By Dr. Stephen Miall. Pp. iii + 26. (London: Benn Bros., Ltd., 1922.) 1*s.* 6*d.* net.

DR. MIALL states that he has published this pamphlet in the hope that it "might interest, and even instruct, some junior students of chemistry." To treat of the structure of the atom, radioactive changes, isotopes, and the octet theory in twenty-six pages, and in such a way as to be clear and interesting as well as accurate and instructive, is a task which calls for no little skill. Dr. Miall has undertaken it with a great measure of success, and his small pamphlet should fulfil the object he had in mind in its publication. If he had given some account of Sir J. J. Thomson's recent theory the whole range of the subject would have been covered: perhaps he will do this in future issues.

Insects and Human Welfare. By Prof. C. T. Brues. Pp. xii + 104. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1920.) 10*s.* 6*d.* net.

THOUGH embodying no original research, this book is a useful and pleasantly written compilation of the results achieved by economic entomologists (including medical investigators), and of the tasks that are yet to be undertaken in Man's battle with his most formidable rivals on earth. The majority of the statistics and facts narrated are from the United States; but this circumstance in no way impairs their value to the British reader, whether doctor, farmer, or forester.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The Small Haloes of Ytterby.

The following letter, received from Mr. Svein Rosseland, of the Institute of Theoretical Physics, University of Copenhagen, contains an interesting suggestion. I publish it with the writer's consent.

"... In connection with your letter to Nature of April 22 on radioactive haloes in Ytterby mica I venture to comment upon the probable location of the hypothetical element in the periodic table. You make in your letter the interesting remark that the element cannot belong to the radioactive disintegration series previously known, since the life period, according to the Geiger-Nuttall relation, would have to be so immensely large, and the intensity of the radiation correspondingly feeble, that it is difficult to believe that the radioactivity of the element could be detected. This remark raises the question of the origin of the energy of the α-particles and the meaning of the above-mentioned relation.

Now it is known that the α-particles are strongly repelled by the nuclear electrostatic field of the parent atom, and it is clear that this repulsion must contribute appreciably to the energy of the particle. Without further knowledge of the exact dimensions of the nucleus and the character of the field close to it we cannot of course calculate the relative importance of this energy in the resulting energy of the particle, but we can calculate inversely a minimal radius for the nucleus of the transformation product by supposing the whole energy to be due to the nuclear electrostatic repulsion.

In this way we obtain a series of minimal radii for the elements consecutive to the α-radiating elements. The longer the life period the larger is this radius. The largest radius is afforded by uranium-X_1, where, corresponding to a range of 2·53 cm. N.P.T., it comes out as $6{\cdot}5\times 10^{-12}$ cm. This value is so large that in view of the experiments on single scattering it seems improbable that the real radius will be much greater. But then we are led to the assumption that the main part of the energy of the α-particle from uranium-1 comes from the nuclear repulsion. As it seems unlikely that variations in the nuclear dimensions will be so large as to account for the energy of the swifter α-particles, there must be an energy term of expulsion from the nucleus, resembling in some respects the energy difference between two stationary states of an atom. If we assume the term due to electrostatic repulsion to be only slightly variable, as is the case if the nuclear dimensions vary but slightly, the variability of the ranges of the α-particles will be due mainly to variations in this energy of expulsion, and it is this which is linked to the life period of the elements according to the Geiger-Nuttall relation. It seems not wholly improbable that the difference between the constants in this relation corresponding to the different series may ultimately be due to differences in the nuclear dimensions.

If the Ytterby haloes were due to an element of an atomic number of the order found in the families of the known radioactive elements, the nuclear dimensions of its transformation product would be nearly 1·8 as large as that calculated for uranium-X_1. If, on the other hand, we reject such a size for the nucleus as improbable, we can calculate the atomic number of the element in question by assuming a law for the large scale variation of the nuclear radii, assuming at the same time the energy of expulsion of the transformation to be small. As the volume of the protons included in the nucleus on the basis of current opinion is negligibly small, it seems natural to assume as a rough approximation that the volume of the nucleus is simply the sum of the volumes of the individual electrons contained in the nucleus, where, however, this electronic volume is not necessarily equal to that calculated from the mass of the electron. This assumption is equivalent to assuming the nuclear radii to be proportional to the third root of the number of electrons in the nucleus, $A-N$, where A is the atomic weight and N the atomic number.

Calculating in this way the radius of the transformation product of the element in question corresponding to a range of 1 cm. in air we finally arrive at an atomic number in the neighbourhood of 40. Since the β-radiating element rubidium is number 37 this calculation immediately suggests that hibernium is identical with yttrium, which is related to rubidium just in the right way to account for the β-radioactivity of the latter.

This calculation of course is to be regarded merely as a suggestion, but I should be interested to know if yttrium were ever found to be associated with Ytterby mica."

The conclusion arrived at by Mr. Rosseland seems not improbable. In a paper by Ivar Nordenskjöld (Bull. of the Geol. Inst. of Upsala, vol. ix.) two analyses of the black mica of Ytterby are given, one referring to a much altered variety and the other to a less altered mica. The former contains yttrium, the latter contains none. This suggests that the yttrium has been introduced in the process of alteration. The mica containing the reversed or bleached haloes has, to all appearance, been considerably altered. It is therefore probable that it contains yttrium. On the other hand, according to Mr. Rosseland's theory, rubidium should be present, or—derived from it by loss of a β-ray—strontium. Neither of these elements appears in the analyses. Nor am I aware of any mineral analysis in which there is an association of any two of the elements in question. But it is, of course, quite possible that spectroscopic examination of yttrium minerals would reveal such traces of rubidium and strontium as would support Mr. Rosseland's deductions.

J. Joly.

Trinity College, Dublin.

Muscular Efficiency.

In Nature, April 15, 1920 (vol. 105, p. 197), there is a letter of mine on this subject, and the proposition there given relating to maximum efficiency is in the following applied to the case of the most efficient speed for a bicycle. The values chosen for the constants are merely guesswork, but the result is more or less in accordance with the facts.

The assumptions made are:

(1) The total power developed remains constant.

(2) All the power used in the acceleration of the limbs is lost.

(3) There is a perpetual leakage of power when a muscle is exerting any force.

I do not suppose that (1) is strictly true, but the tendency is in that direction.

I believe that (2) is correct, for no energy is restored when a contracted muscle is again extended either by the action of outside forces or by the contraction of other muscles.

(3) also is true, but in what way the leakage varies with muscular stress is not known. It probably lies between "as the force" and "as the square root of the force," and in this note I shall assume the latter hypothesis.

If P, P_A, P_L are respectively the total power developed and the powers lost by acceleration and leakage, then, f and v being the force and velocity, $P=fv$, $P_A=A/f^3$, and $P_L=Bf^{\frac{3}{2}}$.

The useful power is $P_E=P-P_A-P_L$, and the efficiency $E=1-\frac{P_A+P_L}{P}$. Differentiating E with respect to f it will be found that the minimum of P_A+P_L occurs when $f=\left(\frac{2A}{B}\right)^{\frac{2}{9}}$.

The constants A and B may be determined by the conditions that, when the whole power is expended in accelerating the limbs $A=f_a^3P$, where f_a is the force which can be maintained at the greatest practicable velocity, and $B=P/f_L^{\frac{3}{2}}$, where f_L is the greatest average force which the muscles can apply.

In the case of the bicycle I will assume (1) that the gearing is 70 with a 7-inch crank; (2) that the power available is 40 ft. lb. per sec. (about 1/14 H.P.); (3) that the greatest speed attainable with that power and in the absence of air resistance is 40 ft. per sec. (about 28 M.P.H.); and (4) that the greatest average force which can be continuously exerted on the crank is 30 lbs., from which it may be deduced that A = 5000 and B = ·24.

These values were used in computing the curves in Fig. 1.

The minimum of P_A+P_L is 12·5 ft. lbs. per sec., thus leaving 27·5 ft. lbs./sec. for useful work, which, with the assumed length of crank and gearing, would

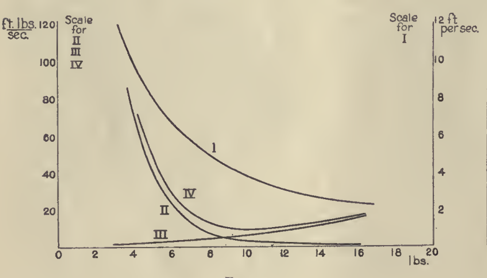

FIG. 1.

Curve I is the hyperbola $fv=P$; f in lbs., v in ft. per sec.
,, II P_A, the power lost in acceleration of the limbs.
,, III P_L, the power lost by leakage from the strained muscle.
,, IV P_A+P_L, which has a minimum value of 12·5 ft. lbs./sec.

suffice to lift a load of 200 lbs. (weight of rider and machine) up a gradient rather less than one in thirty. Hence even with this gentle gradient it would pay to ascend the hill obliquely, *i.e.* in a series of tacks.

The P_A+P_L curve, however, is very flat near the minimum, so that a considerable increase of gradient would not do much to diminish the efficiency.

Whether the assumed maxima of speed and force are anywhere near the truth I do not know, and it would be interesting to have laboratory experiments on these quantities.

A. MALLOCK.

9 Baring Crescent, Exeter, May 10.

"G. B. M."

I FIRST saw the late G. B. Mathews on June 4, 1884, at the Queen's Hotel, Chester, when the staff of the newly founded University College of North Wales was appointed. He was chosen for the Chair of Mathematics, and almost from that time we were linked together in friendship as well as in our offices as teachers of intimately related subjects in the same institution. I well remember his youthful and striking yet attractive appearance. He was the senior wrangler of the previous year, and came full of eager enthusiasm for the teaching of mathematics and for original mathematical work, and for ten years laboured hard in the hope of founding something like a school of mathematical study in North Wales. But alas! these hopes were dashed. Perhaps he was a little impatient, and I certainly did my best to counsel him to wait, and to find out the effect of the new Welsh university on the studies of the place, but without effect. The best of the Welsh students were at that time attracted by the Neo-Hegelian philosophy, and some of them, as seems to be the way of such students, seemed not a little proud that their mental tendencies were not mathematical. To this curious type of intellectual pride Mathews referred eloquently in the posthumous paper published in NATURE of April 22.

In that paper he lamented the revival of the fallacious arguments for the supremacy of the Latin-Greek classics as an educational instrument; but he in no way undervalued classical culture, only he thought that to an Englishman, the inheritor of a copious and flexible language, and of a literature unequalled in the past, a training in Latin and Greek was far from indispensable, and might have its disadvantages. Certainly many classical people, tutors of colleges and old-fashioned classical schoolmasters, often write English which can scarcely be regarded as a model to be imitated, as any one can convince himself by reading the prefaces and introductions to editions of classical texts. He always thought Greek more important for students of science than Latin. And truly the technical language of zoology and physiology, and in a less degree that of physics, is much more exclusively of Greek than of Latin derivation.

Mathews had a knowledge of Latin and Greek as minute and accurate as that generally possessed by professional classical scholars. He wrote pure and elegant Latin. I remember his amusing himself by turning into Latin prose an original philosophical dissertation which happened to come into his hands and arrested his attention. I remember also some Latin verses which he published anonymously and which were much praised by a very eminent scholar.

He wrote also charming English essays in the style of Charles Lamb, of whom he was a great admirer. These I fear are lost, but one of them, "On a cock-loft," was a perfect gem, a charming piece of the most natural and simple prose, somewhat after the manner exemplified more recently by Kenneth Grahame in his "Golden Days." He gave much time to Arabic in later years, and it is to be hoped that his translations of Arabic poetry will ultimately be published. I have seen some of them, which certainly seemed very remarkable. His most valuable work was done in mathematics, and this has been well appraised by a mathematician who knew him well in later years. It is, I think, a pity that the variety and strength of his interests distracted him from mathematical work, and prevented him, until it was too late to take it up again, from finishing his work on the Theory of Numbers. But in his NATURE articles his extraordinary wealth of knowledge and his keen and yet genial criticism must have helped innumerable students. A. GRAY.

The University, Glasgow.

Half Quanta.

THE Wilson-Sommerfeld principle when applied to the case of a rotating molecule, supposed rigid, leads to the expression $mh/2\pi$ (m integral, h Planck's constant) for the angular momentum of the molecule, and on this basis, with the help of several other assumptions, it has been found possible to account very satisfactorily for the main features of the structure of band-series. The theory is found to apply not only to ordinary bands in the region of the visible spectrum but also to absorption bands of very different appearance, such as those due to the halogen acids which occur in the infra-red. In the latter case, however, a discrepancy exists which has given rise to a good deal of discussion. The observed bands consist of a number of lines distributed, to a first approximation, according to the formula

$$\nu = \nu_0 \pm m\omega,$$

where m takes successive positive integral values and ω is a constant. The line of wave-number ν_0 (*i.e.* $m=0$) is invariably absent.

The theoretical expression, on the other hand, is of the form

$$\nu = \nu_0 \pm (m - 1/2)\omega,$$

which, it will be noted, represents a similar set of lines displaced through a distance $\omega/2$. The reality of the discrepancy is therefore dependent upon the correct identification of ν_0, and as this is not entirely beyond question some workers have preferred to take the value indicated by the theory, although by doing so fresh difficulties in the interpretation of the results arise. Einstein, however, pointed out (quoted by Reiche, *Zeitschr. f. Phys.*, 1920, p. 283) that theory and observation would agree if instead of the usual value $mh/2\pi$ for the angular momentum one assumed it to be given by $(m+1/2)h/2\pi$. The evidence from the infra-red absorption bands seems scarcely strong enough to warrant such a revolutionary change, but other data bearing on the question have recently become available. In the band spectrum of helium, for example, series exist which show this same peculiarity, and here its existence is indubitable, for the normal (*i.e.* theoretical) series are in this case also present, and a trustworthy value for ν_0 can be determined from them.

Following up Einstein's suggestion, I have found that the abnormal series may in all cases be very simply derived from the normal group by displacing the quantum number by one-half. As an illustration of the sort of agreement which is obtained I may cite the case of the $\lambda 5730$ band (see Curtis, Roy. Soc. Proc., 101, 1922, p. 38), which consists of six series, only three of which satisfy completely the theoretical requirements. The "half-quantum series" calculated from these three are as follows:—

$$17436{\cdot}6 - 31{\cdot}5m + 0{\cdot}95m^2$$
$$17436{\cdot}6 + 31{\cdot}5m + 0{\cdot}95m^2$$
$$17436{\cdot}6 + 0{\cdot}95m + 0{\cdot}95m^2$$

The remaining three observed series are represented by the formulæ:—.

$$17437{\cdot}3 - 30{\cdot}0m + 0{\cdot}87m^2$$
$$17436{\cdot}8 + 29{\cdot}5m + 1{\cdot}09m^2$$
$$17437{\cdot}3 + 1{\cdot}15m + 0{\cdot}87m^2$$

The correspondence is very close, having regard to the approximate character of the formulæ upon which the calculation is based. It is certainly good enough to justify the proceeding as an empirical method of expressing the relationship between the two groups and to encourage theoretical inquiry into its physical significance.

As the matter stands at present, the inference—illusory though it may be—is that the molecules fall into two classes, according to whether their angular momenta are given by $mh/2\pi$ or by $(m+1/2)h/2\pi$. Transitions between the two classes do not occur (or, if they do, give rise to no radiation), since there are no lines corresponding to changes of one-half in the quantum number. That is to say, whether or no the half-quantum may be involved in the determination of the possible states of a molecule, it does not appear to play any direct part in the radiation process.

W. E. CURTIS.

Wheatstone Laboratory, King's College, W.C.2.

Fossils in Burmese Amber.

AMBER mines have long been known in Upper Burma, or rather in the adjacent "unadministered tracts." In 1916 Mr. R. C. J. Swinhoe, of Mandalay, began to send me specimens of Burmese amber (Burmite) containing insects. As opportunity has offered, he has continued to obtain such material, all of which has been transmitted, after investigation, to the British Museum (Natural History). Up to the present time I have been able to describe 38 species of insects, three arachnids and one diplopod. Many other species, which I did not feel competent to deal with, or which could not be seen properly, exist in the amber, and will, I hope, eventually be described by others. On the whole, the fauna is very remarkable, containing a large preponderance of types which are usually considered primitive. The amber was said to come from Miocene clay, in which, however, it was presumably of secondary origin. Judging from the fossils, I suggested as early as 1917 that the amber might be actually very much older than Miocene, conceivably even Upper Cretaceous (*Amer. Journ. Sci.*, Nov. 1917, p. 360).

Recently, information has been received which tends to confirm the suspicion that the amber is much older than Miocene. Dr. F. A. Bather of the British Museum has kindly transmitted a letter from Dr. E. H. Pascoe, Director of the Geological Survey of India, dated July 20, 1921. Dr. Pascoe states that Dr. M. Stuart, in his recent journey down the Hukong Valley, saw something of the amber mines, and reported that the shafts were sunk in beds which appeared to be identical with the Tipam sandstone or the Irrawaddy series. Whether they passed through into underlying rocks could not be determined, but from the evidence obtained by Noetling and others it seemed probable that they frequently did. The Tipam sandstone is unconformable on the underlying beds, and frequently contains fragments of them in its lowest horizons. Such fragments may very well include lumps of amber derived from the underlying clays. Dr. Pascoe continues: "Among the debris of some pits sunk into these clays, which are the true home of the amber, Dr. Stuart found a fragment of chalky nummulitic limestone. The pits had been sunk into the clays, not to obtain amber, but flint from the chalky limestone lying in them. Dr. Stuart describes the clays as totally unlike any Disang beds that he had seen, and he is inclined to accept the view that they are Eocene in age. If it is possible to determine the species of the nummulite, I will let you know; but it is, of course, not certain that this nummulitic limestone occurs *in situ* within the clays."

On August 1, 1921, Dr. Pascoe wrote that Dr. Stuart thinks the nummulite is *Nummulites biaritzensis* d'Arch., characteristic of the uppermost zone of the Lower Khirthar. The Khirthars correspond approximately, according to Mr. E. Vredenburg, to the Lutetian. The Lutetian represents the earlier part of the Middle Eocene, below the Bartonian.

Thus, the evidence seems to indicate that the Burmese amber fauna is Eocene, and older than the Eocene (Bartonian) beds which have produced fossil insects in the south of England.

At this point, however, a new problem is introduced. A few days ago I received from Mr. Swinhoe a number of beads of extremely pale and pellucid amber containing well-preserved insects, all different from those previously described. These insects include a small bee, which seems not to differ at all from the common living Indian *Trigona lævicep*s Smith. The other amber contained no ants, but this includes a worker of Crematogaster, workers of Pheidole, and males of Monomorium. I also find a winged termite, a psyllid, a fly of the genus Phlebotomus, some acalyptrate muscoid flies, a mycetophilid, some small spiders, etc. So far as can be seen, this is a modern series of types. Mr. Swinhoe found that the beads, when he purchased them, had been artificially coloured to enhance their value, and he had this colouring matter removed. He learned that several stained necklaces had been imported from China, so he could not be sure that the material was really from Burma. At one time he even wondered whether the specimens could have been included in artificial amber, as is sometimes done. He decided that this last suspicion was unfounded, and I quite agree. His letter ends: "Probably this light amber comes from a locality a few miles off." My own opinion is that this light amber (or copal) is of very recent origin, not earlier than Pleistocene, and contains a fauna which doubtless consists mainly (at least) of species still living. The bee which I recently described as *Meliponorytes* (?) *devictus* probably belongs to this material, and not to the Eocene amber. We may surmise that we have the product of some Dipterocarpaceous tree allied to Vateria; something similar to Miss Ruth Holden's *Dipterocarpoxylon burmense*, based on fossil wood from Burma. More exact information on this matter is greatly to be desired.

T. D. A. COCKERELL.

University of Colorado, May 1, 1922.

Radium Synthesis of Carbon Compounds from Air.

Now that photo-synthesis is attracting special attention it may be interesting to record some recent preliminary experiments on the production of synthetic carbon compounds by the action of radium rays on atmospheric air. Under normal conditions of temperature and pressure, it seems evident that this radio-synthesis is capable of producing carbon compounds apart from living cells, and without the agency of solar radiation.

The experiments arose from an observation, made some nine years ago, during an investigation of the curvature of thin plates of mica when acted upon by radium. After long exposures—some weeks in duration—I noticed a deposit of brown patches, mere specks, on the uppermost side of the thin strips, that is, the side which became concave during α-ray bombardment.

As this deposit was found not to be responsible for the bending, it was not mentioned in the resulting paper (Journal Röngten Society, No. 44, vol. xi., "Alpha Ray Effect Mechanical"), but left for future investigation, which eventually had to be abandoned on account of urgent war work.

Having recently made further experiments, I find that the deposits can be detected more quickly, and better observed, by using freshly drawn fibres of quartz or glass, diameter about 0·04 millimetres. Several of these may be spaced about 1 mm. apart, supported on a framework immediately over the radium salt, about one-eighth of an inch above the uncovered radio-active surface (one or two milligrammes of radium or mesothorium is sufficient).

The whole arrangement should be put into a clean cardboard box (about one litre capacity, to reduce convection currents), with loose fitting lid, which is then put away in a dark room. After remaining undisturbed for a week, it will be seen, using a Coddington lens (or better if transferred to a microscope with one-inch objective), that the fibres are covered with a clear white viscid liquid film, which is beginning to gather up into beads, or droplets, at more or less regular distances. After a further exposure of a few days, it will be found that all the droplets have increased in size, some having reached a pale sherry colour. Further exposure leads to increase in size, eventually resulting in dimensions about double the diameter of the fibre. The colour changes may be from white to sherry, red, then dark brown, after about six weeks' exposure; later a little irregularity of contour of the brown droplets may be noticed, showing that the liquid is tending to solidify with irregular contraction; fresh deposits may appear in the interspace between old droplets, so that a fibre may contain droplets in all stages.

It is evident that the first liquid product, colourless at the beginning, is soon oxidised in the ozone which is produced by the α-rays. By reason of the time required and the minute quantity of the first product, it is difficult to make tests before oxidation has taken place to some extent.

Preliminary microscopical examination of the final dark brown product, which becomes a strongly adherent scaly deposit, on a mica strip (after nine years), demonstrated that the brown deposit was insoluble in alcohol and chloroform but dissolved in hot water. On evaporation of this solution a brown film was formed which cracked into scales on drying. This film became carbonised on heating, at about the same temperature as a particle of gum acacia, on the same electric hot-plate.

So far, I have not obtained deposits by using α- β- or γ-rays, either separately or in combination. The gaseous emanation of radium seems to be necessary, which points to the probability that the radium products of short period are chiefly concerned in the synthesis, or in facilitating condensation on solids. On this point, and on the physical aspects, further experiments are in progress, but it is very desirable that the chemical examination of the products should be made by others with better facilities than those I possess for dealing with very minute quantities. Possibly increased production may be obtained by increasing the proportion of water vapour and carbon dioxide in the air. I should be very glad to know of any work already done bearing on the subject. Have such products ever been found in the atmosphere? If ultra microscopical, rain may contain some.

F. HARRISON GLEW.

156 Clapham Road, London, S.W.9.

Cephalic Index and Sex.

IN NATURE of March 23, p. 389, I find the statement—in a summary of a paper by Miss R. M. Fleming—that "British women show more development of pigment, brachycephaly, and prognathism than do men."

As to the cephalic index I see quite the same in Arthur Thomson and Randall-MacIver's interesting account of skulls from "The Ancient Races of the Thebaid" (Oxford, 1905); and probably this "more development of brachycephaly" in women is a general law.

But, as I pointed out in 1907, in my Danish paper, "Om Kortskaller og Langskaller" (Oversigt over D. K. Danske Videnskabernes Selskabs Forhandlinger, 1907)—also published in a German translation in "Archiv für Rassen- und Gesellschafts biologie" (IV., 1907)—such indications need correction because of the correlation between absolute length of skull and cephalic index: the index diminishing greatly with increasing length.

I will here reproduce only one of the concluding tables of my paper in which I have given computations of the English authors' splendid material. The whole of the material (775 males and 754 females) gives for the skulls these averages:

Males: L., 18·426 Br., 13·536 Index, 73·48
Females: L., 17·682 Br., 13·187 Index, 74·58

i.e. showing "more development of brachycephaly" in women.

But if we compare what ought to be compared, namely, the skulls having the same lengths, we find quite different results.

Comparisons of the cephalic index in men and women within the same classes of absolute length are given in the following table:

Limits of Length-Classes.	Index of Skulls.		Difference and Mean Error.
	Male.	Female.	
17 cm. – 17·5 cm.	77·34	75·86	1·48±0·47
17·5 ,, – 18 ,,	75·40	74·28	1·12±0·29
18 ,, – 18·5 ,,	73·88	73·18	0·70±0·30
18·5 ,, – 19 ,,	72·42	71·24	1·18±0·51

The same divergence runs through all special series of the material. The same class of absolute length of head (again correlated with the height of body and so on) shows more development of brachycephaly in *men* than in women!

In this short letter I need not enter into the various questions concerning cephalic index and heredity, Mendelism, etc. W. JOHANNSEN.

University of Copenhagen.

THE point which Prof. Johannsen raises is interesting, though absolute measurements on men and women are scarcely comparable. Absolute measurements on women are not only smaller than those on men of the same type, but also differ in their relationships. As pointed out in a summary of our measurement results in *Man* for May 1922, a range of absolute head length 181-193 mm. in women of a certain race type corresponds with a range of absolute head length 194-204 mm. in men of that race type. It will thus be seen at once that a comparison of a man and a woman having the same absolute head length means a comparison between two people not only of different sex, but also of different race type. In such a comparison one gets a woman towards the long headed end of the series compared with a man towards the short headed end of the series for that sex. The smallest absolute measurements for head breadth are among women, for all women's measurements are small, but at the same time these heads need not necessarily be narrow proportionately to their length, which may also be very small. Classifying race types on the basis of summation of characters our thousands of measurements undoubtedly show that women's heads show greater *relative* breadth (*i.e.* are not so oval in shape) as those of the men nearest to them in general features.

In conclusion, may I refer to Prof. Johannsen's mention of length of head *correlated with height of body*. Our results have gone to show that on the whole the greatest absolute length of head is to be found in a race type the height of which is distinctly sub-normal. The longest headed man I have measured is of this type and is under five feet in height. This of course may not apply to the race types Prof. Johannsen has measured, but it would be interesting to have his observations on the point.

R. M. FLEMING.

The Organisation of Knowledge.

REGARDING the remarks made in NATURE of May 6 on the address of Dr. F. L. Hoffman at the American Association, it might be suggested that the organisation of facts for commercial uses is of a different order than the organisation of knowledge for the purpose of understanding the operations of Nature or of ascertaining a particular law of cause and effect. A man who collects data may, or may not, have imagination. A man may also classify facts quite mechanically according to a scheme laid down. The successful "business organiser," however, usually has a new plan and sets others to work to collect facts for him to organise or re-organise. He knows at the start *why* he wants the facts and *how* to use them. Imagination is required by such an organiser because he has to adjust his methods not only to his data but to human beings and a changing world.

Mathematics, however, in the Pythagorean sense of *Mathesis*, certainly is not necessary for the actuaries' arithmetical operations. But, so far, neither actuaries nor the inductive method of inquiry alone have been able to predict epidemics of disease, revolutions or wars, not to mention earthquakes and tidal waves; nor have they anticipated discoveries of fundamental laws, such, for example, as that of Dalton's doctrine of atomic proportions or Faraday's law of electromagnetic induction. Dalton, we know, was a mathematician and was not personally engaged in collecting evidence; his laboratory work was insignificant. Faraday himself stated that he had reached his conclusion by a *process of thought* and *knew* it must be true before he obtained the evidence by experiment. Who, even then, suspected the industrial results that followed in later years through the application of the principle by others? It is to mathematics in the original Greek sense of principles or proportions (not *calculation* merely) that we owe the really epoch-making discoveries of science. Even inventions are not the result of examining facts. A mechanical genius has a knowledge (instinctive or mathematical) of a law he tries to demonstrate practically; he does not attempt to formulate a law from a collection of facts. The evidence proves the law to the senses; but a law is not created nor even discovered by evidence. Inductive science has been necessary in order that we should become acquainted with the different kinds of materials and variety of species, etc., in the world, for, before Bacon's instructions had been carried out, there was no opportunity to apply the laws of Nature (understood, without doubt, in a general way by Bacon himself) even when a genius with mathematical imagination saw them in his thought. Inductive and deductive methods are each ineffective without the other.

Again, the history of modern chemistry and physics does not support the contention that the laws of mechanical engineering were evolved by rule-of-thumb experiments amongst primitive peoples before, for instance, the pyramids could be built. Modern hydraulic engineering arose in the mind of one Carnot, a mathematical genius who demonstrated its laws

by symbols on paper. Industry and business have benefited considerably from the application of this *unbusinesslike* mathematical method !

The fact is that the most practical sciences, and the only sciences that have been applied industrially, are the exact sciences of chemistry, physics, and engineering—sciences which can predict effects from known causes.

No statement of evidence is really a fact until all the factors are known, and, therefore, statistics cannot predict, and man cannot forestall disease or economic distress, in spite of the sciences of biology and medicine and the "science of economics."

W. WILSON LEISENRING.

IN a notice (NATURE, May 6, p. 596) of an address by Dr. Hoffman, the words are used: "Imagination is what the mathematician is ever trying to get rid of." As such misconceptions as this are unfortunately rather widespread, it may be useful to protest against them. Imagination is essential to mathematics. The work of the great mathematicians affords many striking examples of creative imagination, and for the proper understanding and appreciation of even the elementary parts of the subject the use of imagination is necessary. One of the most important qualities of a good mathematical teacher is the power of stimulating the pupils' imagination, and it is, perhaps, the neglect of this faculty by some teachers which is responsible for the dulness and lifelessness of what is too often taught in schools under the name of mathematics. F. E. CAVE.

Girton College, Cambridge, May 10.

DR. HOFFMAN'S charge against the mathematicians was not that they lack imagination but that they set before them as the ideal of their science the getting rid of it. The quotation from Prof. Whitehead, who certainly is not lacking in that faculty, makes the meaning clear. There is, however, a drawback in our language in the fact that we use the same word for imagination when we mean æsthetic creation, what the Italians call *fantasia*, as we do when we mean the anticipation which is pure reproduction, what the Italians call *immaginazione*. It is of course the æsthetic creation the mathematician aims at dispensing with in order to preserve the purely logical character of his ideas. Even Kant represented it as a kind of handicap that mathematical concepts should require sensuous intuition for their expression. THE WRITER OF THE ARTICLE.

The Elliptic Logarithmic Spiral—a New Curve.

IF, in an elastic system with one degree of freedom, and friction proportional to the velocity, the relation of the "free" force to the displacement be considered, an interesting curve results.

Thus if the displacement be

$$x = ae^{-kt} \cos nt$$

the force is given by

$$F = be^{-kt} \cos (nt + \epsilon),$$

and by eliminating the cosines we have

$$\frac{x^2}{a^2} - \frac{2Fx}{ab} \cos \epsilon + \frac{F^2}{b^2} = e^{-2kt} \sin^2 \epsilon,$$

which may be termed an elliptic logarithmic spiral or a damped Lissajous' curve.

If the vibrations are maintained or forced by a force of harmonic character, the force displacement curves become ellipses.

The same equations hold for the compounding of two damped harmonic motions of equal periods at right angles, so that the path of a body at the lower part of an oiled sphere or of the bob of a conical pendulum in a viscous medium would be, in plan, an elliptic logarithmic spiral. H. S. ROWELL,
Director of Research.

Research Association of British Motor
and Allied Manufacturers,
15 Bolton Road, Chiswick, W.4, May 3.

Intelligence Statistics.

I WAS interested in a short note in NATURE of February 16, p. 218, on the dependence of the standard of intelligence of individuals on the part of the year in which they were born. Statistics appear to show that the standard of intelligence is higher in individuals born in the autumn (say October) than in those born in the spring (say April). At first sight this result may seem rather unexpected, as one might expect that the influence of summer would be beneficial to a child born in the spring, whereas, in the case of a child born in the autumn, it would not be surprising if the succeeding winter were to have a deleterious effect on the mental growth.

It appears to me that the chances of a child surviving the first year of life are greater for a child born in the spring than for one born in the autumn, and I do not doubt but that statistics have shown that this is so. Coupled with this one would expect that the general "fitness" of the survivors of the first year of life would be greater for individuals born in the autumn, because the weaklier members have been weeded out by the severity of winter in the first few months of life. This would appear to be sufficient to explain the result mentioned at the beginning of this letter. We should thus expect that, in the southern hemisphere, children born in the spring (April) would in later life have a higher average standard of intelligence than those born in the later months of the year. Statistics from the southern hemisphere would thus be of value in this connection.

It is possible that this aspect of the problem has already been dealt with. As the papers on this work are not accessible to me, however, I have not seen the explanations offered for the above-mentioned interesting phenomenon. ROBERT W. LAWSON.

The University, Sheffield.

A Rainbow Peculiarity.

IN NATURE of March 9, p. 309, Major Lockyer asks if it is a fact of general observation that "the whole area of the inside of the primary bow is brighter than the region outside," and he refers to the phenomenon as "a fact in Nature which appears to have been rarely noticed visually." The following quotation from "The Divine Adventure," by Fiona Macleod (William Sharp), shows that the mystic poet not only saw clearly into the heart of Nature, but was also a keen observer of her outward manifestations:

> It is not Love that gives the clearest sight:
> For out of bitter tears, and tears unshed,
> Riseth the Rainbow of Sorrow overhead,
> And 'neath the Rainbow is the clearest light.

Probably the phenomenon was commonly known amongst the Western Isles he loved so well.

JOHN P. DALTON.

University of the Witwatersrand, Johannesburg.

Non-Specific Therapy.

By Dr. J. STEPHENSON.

IN inoculation against typhoid fever, dead typhoid bacilli are injected subcutaneously or into a muscle. Inoculation against plague consists in the injection of an emulsion of dead plague bacilli artificially grown in broth. These are prophylactic measures for the protection of persons who are likely to be exposed to infection. Hydrophobia vaccine, used in order to prevent the development of the disease in persons who have been bitten by a rabid animal, is prepared according to a definite system from the spinal cords of rabbits inoculated with the disease. Antidiphtheritic serum, used in the treatment of patients actually suffering from diphtheria, is the blood-serum of a horse which has had diphtheria toxin (the broth in which diphtheria bacilli have been grown, and from which the bacilli have been filtered off) repeatedly injected into it.

In using vaccines the object is to stimulate the individual to produce protective substances in his own body; in using sera, the protective substances, elaborated by some other animal, are themselves supplied to the patient. But in all the above instances, and in numerous other similar modes of treatment,—whether the treatment takes place before infection (*i.e.* is prophylactic), or is carried out during the incubation period, or during the actual disease; whether bacilli are used, or a serum free from bacilli but containing an antitoxin,—the implication is that certain substances are protective against one disease, certain other substances against another; in other words, the treatment is *specific*. The idea of specificity may go even further, as where a patient is treated by means of the particular strain of micro-organism, or the particular mixture of them, that he himself harbours (the use of autogenous vaccines in asthma, acne, boils, etc.). As Sir Almroth Wright has recently written:—

"That immunisation is always strictly specific counts as an article of faith; and it passes as axiomatic that microbic infections can be warded off only by working with homologous vaccines, and that we must in every case, before employing a vaccine therapeutically, make sure that the patient is harbouring the corresponding microbes."

To attempt treatment on a non-specific basis would seem therefore at first glance to be a step backward, and investigation of such a subject illogical, if nothing worse. But while reason, working on the accepted lines, was all against the idea, facts have cropped up repeatedly which seem to give a value to non-specific treatment. At first these were ignored; but a time has come when this method of disposing of them is no longer possible. Thus, to quote Wright again:—

"I confess to having shared the conviction that immunisation is always strictly specific. Twenty years ago, when it was alleged, before the Indian Plague Commission, that anti-plague inoculation had cured eczema, gonorrhoea, and other miscellaneous infections, I thought the matter undeserving of examination. I took the same view when it was reported in connection with anti-typhoid inoculation that it rendered the patients much less susceptible to malaria. Again, some years ago, when applying pneumococcus inoculations as a preventive against pneumonia in the Transvaal mines, I nourished exactly the same prejudices. But here the statistical results which were obtained in the Premier Mine demonstrated that the pneumococcus inoculations had, in addition to bringing down the mortality from pneumonia by 85 per cent., reduced also the mortality from "other diseases" by 50 per cent. From that on we had to take up into our categories the fact that inoculation produces in addition to "direct" also "collateral" immunisation. This once recognised, presumptive evidence of collateral immunisation began gradually to filter into our minds. . . . From such cases hints are conveyed to us that there may exist a useful sphere of application for collateral immunisation; . . . we should discard the confident dogmatic belief that immunisation should be strictly specific, and that we should in every case of failure endeavour to make our immunisation more and more strictly specific. We should instead proceed upon the principle that the best vaccine to employ will always be the vaccine which gives on trial the best immunising response against the microbe we propose to combat."

The present position of non-specific therapy is explained in a recently published volume by Dr. Petersen of Chicago,[1] from which the above quotation from Wright is taken. When we come to inquire into the rationale of the procedure, we find that a theoretical basis to account for the results has been lacking,—the treatment has been empirical. With Petersen, we may perhaps put the matter broadly thus: the reaction of the body is fundamentally the same in all cases of injury; there is an effort to dilute the noxious agent (increased flow of lymph), to remove it (phagocytosis by leucocytes), to neutralise it (manufacture of antibodies); these failing, to wall it in. We may, in trying to influence this process, adopt one of two avenues of approach; we may proceed against the cause of the inflammatory reaction by fostering the production of an antibacterial agent or an antitoxin; treatment on these lines must necessarily be specific, must be directed against the particular micro-organism or toxin. Or we may endeavour to alter the inflammatory reaction of the body itself,—to stimulate the potential forces, latent or held in abeyance until the non-specific stimulation brings them into activity. This is somewhat vague; Wright has, in a recent lecture (see the *Lancet*, May 6), described one way, at least, in which the activation works. He has discovered that "the intravenous injection of a vaccine is immediately followed by the appearance of bactericidal substances in the blood, which are not specific but can act upon various types of organisms. . . . The late result of an inoculation with, say, a typhoid vaccine, is the production of antibodies which are specific for the typhoid bacillus, but the immediate result of such an inoculation is the appearance of non-specific antibodies. Inasmuch as leucocytes possess the power of inhibiting the growth of organisms on culture media, it seems likely that these non-specific substances exist ready-formed in the leucocytes which yield them in response to the immediate demand."

[1] Protein Therapy and Nonspecific Resistance. By Dr. William F. Petersen. Pp. xviii+314. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1922.) 21s. net.

Already a large number of substances have been used as non-specific agents; in many cases, of course, these remedies were employed long before any explanation of their action had been formulated on the above lines. Of the long list of agents given by Petersen only a few can be mentioned.

First comes counter-irritation by means of thermo-cautery, seton, blisters, etc. Each of these procedures has for object the production of a focus of inflammatory exudation, suppuration, or necrosis; the absorption of the pathological exudates must lead to a tissue stimulation similar to that which follows more modern non-specific injections. Our non-specific therapy is thus but part and parcel of this older practice of counter-irritation.

Normal animal sera have been used,—horse, beef, goat, sheep, chicken, and other sera; these were first injected subcutaneously, and in more recent years into a vein; as much as 250 c.c. of beef serum have been given in anthrax without injury. Antibacterial sera and antitoxins have been widely used,—diphtheria and tetanus antitoxin, antistreptococcic, antipneumococcic, antidysenteric serum, etc.;—as remedies, that is, not in the homologous diseases, but in other morbid conditions, *e.g.* diphtheria antitoxin against streptococcus infection, tuberculosis, lupus, etc. The numerous vaccines, prepared in the first place as specific agents,—typhoid, dysentery, streptococcal, pneumococcal, influenza vaccines,—have also been used with a non-specific object.

Various native proteins have been given,—solution of egg albumen and serum albumen injected subcutaneously, milk by intramuscular injection, casein, gelatin; of protein split products, proteoses (albumoses) prepared from different proteins sometimes give a very prompt and satisfactory reaction. The enzyme treatment of cancer, exploited some years ago, consisted in the subcutaneous injection of a trypsin solution; a general reaction,—chill, sweating, and rise of temperature,—followed the injection, and the patient would have several days of comparative comfort.

Colloidal metals constitute another group of remedies; these are active catalytic agents, and it is supposed that they act therapeutically in virtue of this property as inorganic ferments; they whip up the organism, which responds, if response is possible, by producing more leucocytes. A number of colloidal metals have been prepared for therapeutic employment; the colloidal silver preparations have been in use longest, but arsenic, zinc, gold, manganese, iron, mercury, and other metals, as well as sulphur and iodine, have been employed with varying success in septic conditions, endocarditis, rheumatism, trench fever, etc.

The use of light, Röntgen rays, and radium must also be mentioned. These agents first stimulate tissue cells, and later, with prolonged exposure, cause their death. In both cases substances enter the blood stream which produce a general reaction; this may be mild, or accompanied by severe fever. After moderate reactions of this type, if the patient is in good condition and able to respond, improvement of appetite, nutrition, and general well-being may set in, just as after other non-specific agents. Here, then, we have at least a partial explanation of the effect of heliotherapy in tuberculosis, as used, for example, at Leysin in Switzerland, of which the public has heard much in the last few months.

About half of Dr. Petersen's book is occupied with an account of the methods used and the results obtained in the numerous diseases for which non-specific therapy has been tried. The last chapter, on indications and contra-indications, gives much useful advice. We are reminded that the method can only be applied intelligently if we recognise that by it all the forces of cellular and humoral resistance are for a short period of time keyed to the highest pitch; stimulation of this kind is useless when the cells of the body are profoundly fatigued, and hence injections must be given early in the course of the disease. But "the non-specific method of treatment should under no circumstances be considered as a rival or a substitute for the proven specific measures that we have at our command. That a non-specific factor is at times and possibly often associated with the specific reaction may be true, the more reason that both should be studied and both utilised in their proper time and place."

The bibliography runs to no less than fifty pages, and must, one would think, be complete up to date. The book as a whole forms an interesting, convenient, and comprehensive account of a recent development of medical thought and practice.

The Solvay Institute of Chemistry.

THE first meeting of the "Institut International de Chimie Solvay" was held in Brussels on April 20-27, under the presidency of Sir William Pope. It will be remembered that before the war M. Ernest Solvay set aside a capital sum to be expended in the course of thirty years by the International Institute of Physics, and that meetings under the auspices of this Institute have been held in Brussels both before and since the war. More recently M. Solvay has set aside a further capital sum of one million francs, also to be expended in thirty years, for the promotion of the science of chemistry.

The meetings of the Institute are attended by delegates from different countries, the number being limited to about thirty, so that the discussions may be as free and as informal as possible. The recent meeting was devoted to the consideration of a number of those questions which affect the foundations of modern chemistry, and its programme included the presentation of papers on isotopes, by Soddy, by Aston, and by Perrin and Urbain; on X-ray analysis and molecular structure, by W. H. Bragg; on the electronic theory of valency, by Mauguin; on optical activity, by Pope and by Lowry; and on chemical mobility, by Job.

In connection with the papers on isotopes, considerable discussion was aroused as to the possibility of two dissimilar arrangements of planetary electrons around the same type of nucleus. The possibility of such an isomerism in the external domain of the atom was conceded, although at present only as a hypothesis;

but, in view of the fact that radiation by the atom is attributed to the movement of electrons from one orbit to another, the prospect of realising two different stable configurations of the orbits appears somewhat remote. Another possibility, that atoms may exist of equal atomic weight as well as of equal atomic number, has been discussed in connection with certain members of the radium and actinium series or radio-elements. The supposed necessity for recognising this subtle type of distinction between atoms is based on the assumption that radium and actinium are derived from a common parent and that all the members of both series of radio-elements must therefore have atomic weights of the type $(238-4n)$. If, however, radium and actinium are derived from isotopic forms of uranium, the two series of radio-elements may well prove to differ in atomic weight, *e.g.* by one unit. The discussion on Aston's paper dealt largely with the question of how an "element" should be defined, in view of the discovery of isotopes not only amongst radio-elements but also amongst the common elements. Aston appeared to voice the feeling amongst physicists by suggesting that each atomic number should represent one element; but he was opposed by a number of chemists, who argued that the word "element" carried with it an idea of homogeneity which could not be reconciled with the proposal to describe as an element a mixture of isotopes, the separation of which might at any time become a practical possibility. The paper on the separation of isotopes, presented by Perrin and Urbain, was to have been prepared by the late Prof. Guye. It certainly served to emphasise the extreme difficulty of the separation, since nearly all the methods derived from analogy with rare earths or isomeric hydrocarbons have been shown, both by theory and by experiment, to be impracticable.

Bragg's demonstration of recent results obtained by the X-ray analysis of crystals was greatly aided by models, which could be not only viewed at close quarters, but handled and studied during the whole period of the conference. Some discussion arose in connection with his demonstration of the relationship between the crystal structure of diamond and of graphite, and of the two kinds of relationship between carbon atoms which are shown by the model of graphite. Two different kinds of linkage were also shown between atoms of bismuth, corresponding perhaps to co-valence and electro-valence respectively. The principal subject of discussion arose, however, from the application of X-ray analysis to organic compounds and a bewildering array of chemical problems was suggested, in connection with which X-ray analysis might lead to useful results. A modification of Barlow and Pope's theory of crystal structure, in which a quadrivalent atom is represented by an aggregate of four unit spheres, was described, and shown to present many points of close agreement with the crystalline structure actually recorded in organic compounds.

The discussion on the electronic theory of valency which followed Mauguin's paper included perhaps a larger proportion of adverse criticism than is usually accorded to it. In particular, the lack of any adequate explanation of variable valency, and the indeterminate character of the valency equations (which do not admit of a unique mathematical solution) were the subjects of much comment.

The discussion on optical activity dealt mainly with the usefulness or otherwise of retaining the idea of the asymmetric carbon atom. It was agreed that the asymmetry of the molecule was the only thing that mattered; but expression was given to the view that the term was of value as enabling the organic chemist to recognise at once the existence of many cases of molecular asymmetry, although this might still be looked for in many cases where no asymmetric atom was present. In the discussion on rotatory dispersion the idea was expressed that liquid media which gave rise to complex dispersion-curves might be suspected of containing more than one type of optically-active molecule; in the case of coloured compounds, however, a looped curve might result from the presence of an absorption band in the region under investigation.

The discussion on chemical mobility was for the most part focussed on the radiation theory of chemical action. The lack of agreement between the predictions of the theory, and the results obtained in seeking to verify it, was emphasised. Thus, the observed temperature coefficient of the thermal dissociation of phosphine leads to the conclusion that an absorption band should appear in the violet region of the spectrum. No such band is found, and the theory has therefore been modified in a way which suggests that the active radiations may be found at lower frequencies, *e.g.* in the infra-red region of the spectrum. Actually, however, the change is very sensitive to ultra-violet radiations, and a further modification of the theory would be needed to account for this persistent deviation from the experimental facts.

Universal Wireless Telephony.

In view of the great technical progress that has been made during the last few years in the development of the wireless telephone, and the attention that has been given by the Postmaster-General to the framing of regulations for its orderly use in this country, a considerable popularisation of wireless telephony appears imminent. It is therefore of some interest to examine briefly the facilities as well as the limitations which exist regarding its use. It is obvious that anything like secrecy in conversation over the radio-telephone, as it is now often called, is out of the question, as any one in possession of a half-guinea licence and a receiving set, which can be tuned to the wave-length employed, can "listen in" and pick up the message irrespective of the station for which it was primarily intended. On account of the publicity which thus attends the utterances of the wireless telephone, its field, except in such special cases as aeroplane work, is practically limited to the dissemination of public information, news, music, and other entertainment items, or as it is now commonly called, "broadcasting." Unless, however, these broadcasting stations are rigorously controlled, they will not only defeat their own ends by drowning each

other's messages in a confused babel of sounds, but will interfere with other forms of radio-communication, as already happens to a considerable extent in America.

The most important consideration is that of wave-length, as simultaneous messages at or near the same wave-length mutually "jam" one another, and it may be mentioned that the margin of wave-lengths within which wireless telephone apparatus can be made to "tune out" other messages is not so fine as it is with the best class of wireless telegraph receivers. In order to avoid interference with other established services, the Post Office has allotted the range of 350 to 425 metres to the broadcasting stations. In this connection it should be recalled that the greater part of ship and shore Morse communication is on a 300 to 600 metre wave, and that amateur stations are allowed a wave-length of 440 metres. The well-known Writtle station will work in future at 400 metres, and the Air Ministry wave-lengths are 900 metres for the Croydon aeroplane service and 1400 metres for long-range weather reports, etc., while most of the powerful stations use longer waves up to the 2500 metres of the Eiffel Tower. Possibility of interference will also be limited by allowing broadcasting only between the hours of 5 and 11 P.M. on week-days or any time on Sundays.

Further considerations are the locality and range of the transmitting stations. To avoid too much overlapping, one station will probably be allowed at each of the following points: London, Cardiff, Plymouth, Birmingham, Manchester, Edinburgh, Glasgow, and Aberdeen, and arrangements will be made between the licencees at these stations as to wave-lengths and times of operation within the allotted limits.

With the view of circumscribing to some extent the field of each station, its power will be limited to that corresponding to an input of 1½ kw. The actual distance over which a station can be heard, however, depends more on the receiving than on the transmitting apparatus, but with modern delicate equipment an approximate idea of the possible working range is given by taking about ½ mile for every watt input. Thus, although a simple set may only be able to hear the nearest of such a group of stations, a really sensitive set, say in London, could readily pick up all of them.

The cost of a receiving set for private use in picking up whatever programmes are to be broadcasted, varies considerably with its sensitiveness. Roughly, the minimum that need be expended will depend on the distance from the nearest public station, assuming that to be the only one the owner desires to hear. A set of this kind with a range of 25 miles or so would cost from 5*l.* to 10*l.* complete with the simple aerial that would be necessary. Actually, however, the cost of the equipment selected for any particular case will depend upon whether the apparatus is required to be used to pick up waves from longer distances as well, such as to hear the wireless concerts already being radiated from the Hague, and the time and other signals from the Eiffel Tower. In this case a detector of the thermionic valve tube type must be employed, with one or more degrees of amplification and a greater range of tuning inductances, etc., and a multicell dry battery or other source of voltage for the tubes, as well as the two-cell accumulator, which would otherwise be sufficient. A moderately sensitive apparatus of this kind, with a range of 75 miles or more, would cost about 20*l.*, and further requirements of sensitivity could easily bring the price to, say, 75*l.* Another point influencing the cost of the equipment is the class of aerial which it is convenient to use, as the more sensitive the set the smaller is the aerial with which it will work over a given distance. As a rule, the simple crystal set will require some form of outside aerial, whereas the more delicate set with amplifying valves will give surprising results with a portable aerial, inside a room, composed of a few turns of wire on a rectangular frame.

Although probably the best results are obtained with these sets by the use of headpiece telephones, loud-speaking sets, audible to a number of persons at once, can be used with all the better-class apparatus, and this feature will doubtless add greatly to the popularity of wireless telephone reception.

A number of firms are devoting themselves to the manufacture of this kind of apparatus, including, of course, such well-known establishments as the Marconi Co. The Radio Communications Corporation is also well to the fore, and, as we have already announced, special arrangements are being made at the Trafford Park Works of the Metropolitan-Vickers Electrical Co. Other firms specialising in wireless receiving apparatus suitable for these purposes include Radio Supplies, C. F. Elwell, Ltd., and the R.M. Radio Company. We hope before long to have the opportunity of publishing some particulars of the actual apparatus made by some of these firms.

Obituary.

T. Sandmeyer.[1]

Traugott Sandmeyer, well known to all chemists as the discoverer of the reactions which bear his name, was born at Wettingen in Aargau in 1854. Left an orphan by the death of his father the day after his birth, his mother had to resume her former occupation as a school teacher. His father, who was a science teacher, left a library of scientific books, the perusal of which led young Sandmeyer to interest himself in scientific apparatus, and after spending some time in an engineering workshop, entered the employment of Mr. J. F. Meier, of Zurich, a manufacturer of physical apparatus. Sandmeyer afterwards started business on his own account, and supplied apparatus to the Polytechnic institution. He became in this way connected with the staff of the institution, and in 1882 was appointed lecture-assistant to Victor Meyer.

The story is often told how Victor Meyer, in attempting to show his class what was then known as the "indophenin reaction" with coal-tar benzene, used benzene obtained by distilling calcium benzoate with lime and failed to produce the expected result. It is

[1] This account is mainly gathered from an interesting obituary notice by Dr. Fierz in the issue of the Journal of the Society of Chemical Industry for May 15.

not so well known that Sandmeyer directed the attention of the professor, who had forgotten the incident, to this remarkable difference between the two kinds of benzene, which subsequently led to the discovery of thiophene and its numerous congeners. When Prof. Meyer was transferred to Göttingen in 1885, Sandmeyer accompanied him, but very shortly returned to Zurich, where he became assistant to Prof. Hantzsch. In 1888 he joined the firm of J. R. Geigy, manufacturers of dyestuffs of Basle.

Apart from the Sandmeyer reactions and his remarkable synthesis of indigo from thiocarbanilide in 1899, Sandmeyer's discoveries are little known to chemists unconnected with the synthetic dye industry, in which his later activities lay, and where his greatest successes were achieved. He was a man of reserved habits and made few friends outside the small coterie of his collaborators and fellow-workers, but is described by one, formerly associated with him, as a colleague who was always ready to help and advise. His skill as an expert mechanician, his scrupulous care as an experimenter, and his powers of observation often led him to discoveries which others had overlooked, and the long list of new and valuable dyestuffs of which he was the author placed him in the forefront of colour chemists.

In recognition of his work the University of Heidelberg conferred upon Sandmeyer the degree of Ph.D. *honoris causa* in 1891, and in 1915, at the celebration of the 150th anniversary of the firm of J. R. Geigy Co., of which he had meantime become a director, he was made an honorary doctor of the Zurich Technical School. On his retirement in 1919 Sandmeyer left a large portion of his wealth to the pension fund of the firm with which he had been so long associated.

PROF. H. M. HOWE.

PROF. HENRY MARION HOWE, whose death was recently announced, in his seventy-fifth year, was the doyen of American metallurgists. He was well known both here and on the Continent. He was born at Boston on March 2, 1848, the son of Dr. Samuel Gridley Howe, who was one of the earliest to assist the Greeks in their struggle for freedom. His mother, Mrs. Julia Ward Howe, was the author of the famous "Battle Hymn" of the Republic.

Prof. Howe graduated at the University of Harvard in 1869 in arts, and two years later in science at the Massachusetts Institute of Technology. He then engaged in metallurgical work in Pittsburg, Pa., and Troy, N.J., and soon became known as a keen observer and investigator. In 1880 he designed and built the works of the Orford Nickel and Copper Company at Capeltown in the province of Quebec, and at Bergenpoint, N.J. From 1883 to 1897 he resided at Boston, and set up in private practice as a consulting metallurgist and expert witness in metallurgical patent suits. With this he combined the position of lecturer on metallurgy at the Massachusetts Institute of Technology. He was an original member of the American Institute of Mining Engineering, founded in 1871, and soon contributed to its transactions. His first paper was on "Blast-furnace Economy," which was followed by "Thoughts on the Thermic Curves of Blast-furnaces" and "Nomenclature of Iron," the latter a remarkable contribution to the discussion inaugurated by A. L. Holley in his famous paper, "What is Steel?" His first book, published in 1885, dealt with copper smelting. This was followed in 1891 by "The Metallurgy of Steel," a book which did much to lay the foundations of scientific steel metallurgy, and created for him an international reputation in the subject.

In 1897 Prof. Howe was called to the chair of metallurgy at Colombia College, New York, a position which he filled for some fifteen years. On his retiring to become a consulting metallurgist, he was appointed professor emeritus. He was one of the small band of metallurgists who helped to lay the foundations of the science of metallography, and his name will always be remembered in connection with those of the late M. Osmond, Martens, H. Le Chatelier, Tschernoff, Anossov, Stead, Roberts-Austen, and Arnold. In this connection, his principal contribution is his book entitled "The Metallography of Steel and Cast-iron," a monumental work, which displays a remarkable grasp of the subject and an unusual power of weighing scientific evidence. Prof. Howe was not primarily an experimentalist, although in his later years he published several papers with the late A. G. Levy, dealing particularly with the iron-carbon equilibrium. He was, however, a prolific writer, and in all published more than 300 papers. He was vice-president of the Taylor Wharton Iron and Steel Company, and introduced the manufacture of manganese steel into the United States in 1890.

Prof. Howe was president of the American Institution of Mining Engineers, honorary vice-president of the Iron and Steel Institute, chairman of the engineering division of the National Research Council, consulting metallurgist of the U.S. Bureau of Standards, and research associate of the Carnegie Institution of Washington. Many honours came to him from various countries. In 1895 he was awarded the Bessemer Medal of the Iron and Steel Institute, later the Elliot Cresson gold medal of the Franklin Institute, a special prize and gold medal from the Société d'Encouragement pour l'Industrie Internationale, and finally, in 1917, the John Fritz gold medal, the highest honour in the gift of the engineering institutions of the United States of America. He also received several foreign orders, including the Legion of Honour and the Russian order of St. Stanislas. Prof. Howe was a frequent visitor to this country, and his genial personality will be greatly missed by metallurgists over here.

DR. ROBERT BRUCE-LOW.

DR. ROBERT BRUCE-LOW, the distinguished epidemiologist, died on May 11 after a brief illness. Born in Edinburgh in 1846, he was educated at the Royal High School and University of that city, and graduated in medicine in 1867. After a year spent in post-graduate study in London and Germany, he settled down as a general practitioner, first in Lincolnshire and afterwards at Helmsley in the North Riding, becoming the medical officer of health of the latter district.

This nineteen years of general practice gave him

an insight into the conditions of rural hygiene which was most useful to him in after life. So valuable did the central health authority of those days consider Bruce-Low's work in Helmsley that he was invited in 1887 to become a medical inspector of the Local Government Board, an invitation which he readily accepted. Here he came into intimate association with Buchanan, Thorne-Thorne, and Power, who, as successors to John Simon, were engaged in building up the English public health service. Bruce-Low conducted several inquiries and wrote many important reports for the Local Government Board, the best known of which are those on the progress and diffusion of plague, cholera, and yellow fever, the epidemiology of typhus fever, acute anterior poliomyelitis (1916), and smallpox (1918). Through his epidemiological studies Bruce-Low acquired an intimate knowledge of port sanitary administration, and in reply to an inquiry, furnished the Rockefeller Institute with a statement on the facts which led to the abandonment of quarantine in the United Kingdom. After holding many examinerships for the diploma of public health, he was appointed by the General Medical Council their Inspector of Examinations for degrees and diplomas in public health, work which occupied him for the greater part of the last two years of his life, and the outcome of which was a valuable report and a revised scheme of examination, now under consideration. Bruce-Low became assistant medical officer of the Local Government Board in 1900, retiring in 1911. He served on the War Office Anti-typhoid Inoculation Committee, 1904–12, and on the outbreak of war he was recalled to the Local Government Board, finally retiring in 1920.

Bruce-Low was always ready to help his colleagues, to whom he was a true friend; he was proud of being a Civil Servant, and his distinguished services to his country and to the science of preventive medicine were officially recognised in 1919, when he was appointed C.B.

R. T. H.

WE notice with much regret the announcement in the *Lancet* of the death, on May 18, of Prof. Charles Louis Alfonse Laveran, Foreign Member of the Royal Society, at the age of seventy-six years.

Current Topics and Events.

THE Royal Academy of Belgium celebrated the one hundred and fiftieth anniversary of its foundation on May 23 and 24 in the presence of a large number of its members and of delegates from other academies and learned institutions. On the Wednesday afternoon, May 24, numerous congratulatory addresses were presented at the Palais des Académies, and the members and visitors were afterwards received at the Hôtel de Ville by the Mayor of Brussels, M. Adolf Max, and his Aldermen, MM. Steens, Vande Meulebrouck and Coelst; a reception was held at the Palais des Académies in the evening, where an exhibition of medals and portraits connected with the history of the Academy had been arranged. The anniversary celebration itself was held in the large hall of the Academy on the afternoon of May 25 in the presence of the King, the Minister of Arts and Science, M. Hubert, formerly Rector of the University of Liége, Cardinal Mercier, and the English, French, Dutch, Spanish, and Japanese Ambassadors. The president, M. Vauthier, in an address of welcome, briefly sketched the history of the Academy and its influence on the intellectual development of Belgium. The Minister of Justice, M. Masson, tendered the congratulations of the Belgian Government, and Monseigneur Baudrillart spoke in the name of the Institut de France. Sir William B. Leishman, as vice-president of the Royal Society, represented the British universities and learned societies; he referred to the activities of Belgian bacteriologists and paid a high tribute to the work of M. Jules Bordet. MM. Lameere, Pirenne, and Verlant, representing respectively the classes of science, of letters, and moral and political sciences, and of fine arts, contributed summaries of the activities of their several sections of the Academy. Later the visitors were received by the King and the Queen at the Palace of Laeken, and in the evening a banquet was held at the Hôtel Astoria.

THE Council of the Museums Association has addressed an emphatic protest to the Prime Minister against the proposal to reinstitute charges for admission to the National Galleries and Museums. It is only in recent years that the importance of Museums and Art Galleries as factors in the educational machinery of the country has been fully recognised, and this is due largely to the progressive action of the Government in advocating consistently the policy of free admission and in providing guides which have advanced materially the popularity and usefulness of our National Institutions. The Association feels that the proposed reversal of a policy adopted after many years' experience will be a serious set-back to Museum work, both in regard to the wider education of the nation and the provision of wholesome recreation for the people. If the proposal is adopted it is bound to have an influence on the policy of provincial Museums, the governing bodies of which are largely influenced by the example set by the State. The Association suggests that the far-reaching injury likely to follow the imposition of admission fees would greatly outweigh the small additional income, 10,000*l*., which is expected to accrue.

THE highly controversial subject of the college-trained engineer was chosen by Prof. Frederic Bacon for his presidential address to the Swansea Engineering Association of Students of the South Wales Institute of Engineers. Prof. Bacon had a good deal to say about the conditions which the student is likely to find in works after he leaves college, and the kind of experience which he will then acquire. One of the least satisfactory features of the pre-war position was that scarcely any British firms were undertaking new development work; nearly every innovation in engineering practice was imported from the continent or the United States, a state of affairs

extremely damaging to the prestige of British engineering and very unfair to the scientifically trained engineers of this country. The war showed the capabilities of British men of science and engineers when they work hand in hand and with the necessary resources placed at their disposal. It is the duty of college-trained men to show their faith in science, and to champion her cause when it is unfairly attacked by men who are ignorant of her methods and mission. The engineer can never lose sight of utilitarian ends, but he should know enough of the spirit of science and the recent history of industry and invention to respect and encourage the work of the investigator in pure science.

THE third International Congress of the History of Medicine will be held in London on July 17 to 22 inclusive. The congress will be opened at 10.30 A.M. on July 17 by the Minister of Health at the Royal Society of Medicine, where the delegates will be received and an address will be delivered by the president, Dr. Charles Singer. In the afternoon there will be a reception and an address by Sir Norman Moore, President of Honour, at the Royal College of Physicians. In the evening the President and Mrs. Singer will receive the members of the congress at the Royal Society of Medicine, when an address will be given by Prof. Elliot Smith. The sessions of the congress will be held on the following days from 10.30 A.M. to 12.30 P.M., and from 2.30 P.M. to 4.30 P.M., at the Royal Society of Medicine. A committee of ladies has been organised to conduct ladies attending the congress to various places of interest in London. The Wellcome Historical Museum, 54A Wigmore Street, where a special exhibition will be held, will be open from 10 A.M. to 5.30 P.M. daily. Objects of interest will also be on view in the library of the Royal Society of Medicine. Arrangements have been made for visits to the Royal College of Surgeons, the Society of Apothecaries, the Barbers' Hall, St. Bartholomew's Hospital, and other places of medico-historical interest. Further information can be obtained on application to the general secretary, Dr. J. D. Rolleston, 21 Alexandra Mansions, King's Road, S.W.3.

EXCEPTIONALLY hot weather for the time of year was experienced over the south-eastern and central portions of England on the four days from May 21 to 24, and record temperatures occurred in many places. At the Royal Observatory, Greenwich, observations of the highest order are obtainable for the past 80 years, since 1841, and approximately trustworthy observations can be obtained for as far back as 1814, embracing in all a period of 109 years. In the recent hot spell the sheltered thermometer at Greenwich registered 90°·2 on May 22 and 90°·6 on May 24. The previous records for May since 1841 show only eight days with a temperature so high as 85°, the maximum being 87°·5 on May 26, 1880, followed by 87°·0 on May 19, 1868, and 86°·5 on May 25, 1920, while a temperature of 90° has occurred only seven times during June since 1841, and once only since 1897. The mean maximum shade temperature for the four consecutive hot days was 88°·8, and the mean solar radiation temperature was 148°·5, the maximum being 151° on May 23. In May 1913 there were five consecutive days with the temperature above 80°, the highest temperature being 84°·1 and the mean for the period 82°·2; this is the record for consecutive hot days and also for the number of hot days in the month, the total days being five, the same as this year, which includes May 8 last. In 1870 there were four consecutive days with the temperature above 80°, the mean for the four days being 82°·4. On three consecutive nights during the hot spell the minimum temperature was above 58°, the temperature on the warmest night being 58°·9, and the lowest temperature for four days was 57°·9. Previous records from 1841 show three instances only of warmer nights, 61°·5 on May 25, 1841, 61°·3 on May 24 and 60°·3 on May 29, 1847. The mean daily temperatures at Greenwich for the three days May 22 to 24 were 74°·5, 73°·5, and 74°·8 respectively, which is 20° above the average. The previous highest day mean in May since 1841 was 71°·3 on May 28, 1841, and going back to 1814 the highest day mean was 72°·4 on May 15, 1833. Since the extreme heat of 90°·6 at Greenwich on May 24 the day temperatures steadily decreased, reaching 73° by the end of the week. Thunder-storms accompanied by a heavy fall of hail and rain were associated with the recent hot spell.

AT the annual general meeting of the Institute of Physics held on May 23 in the rooms of the Royal Society, the following Officers and Board were elected to serve for the year beginning October 1, 1922: *President*, Sir J. J. Thomson; *Past-President*, Sir R. T. Glazebrook; *Vice-Presidents*, Sir Charles Parsons, Prof. W. Eccles, Prof. C. H. Lees, Mr. C. C. Paterson; *Non-Official Members of the Board*, Dr. R. S. Clay, Prof. C. L. Fortescue, Prof. A. Gray, Major E. O. Henrici, Sir J. E. Petavel, Dr. E. H. Rayner, Sir Napier Shaw, Mr. R. S. Whipple; *Representatives of Participating Societies:* Physical Society—Mr. C. E. Phillips, Mr. F. E. Smith; Faraday Society—Mr. W. R. Cooper; Optical Society—Mr. John Guild; Röntgen Society—Dr. G. W. C. Kaye; Royal Microscopical Society—Mr. J. E. Barnard. The Annual Report stated that there were 408 Members of the Institute at the end of the year, of whom 258 were Fellows. The Institute is watching the possibility of establishing a central library for physics, although the financial difficulties in the way of its realisation are stated to be considerable. In the course of his presidential Address, Sir J. J. Thomson, after dealing with the project to establish a Journal of Scientific Instruments, spoke of the present depression in industry, but he made the reassuring statement that out of 67 students who graduated with distinction in physics and chemistry in 1921, 46 had obtained suitable positions, while 14 were doing research work. He hoped that the series of lectures on physics in industry which had been established would act to some extent as "Refresher Courses." Speaking of the difficulties which

the Safeguarding of Industries Act had, in many instances, placed in the way of research, he characterised research itself as a "Key Industry," and he hoped that the Government would put every facility in the way of research workers to enable them to obtain without delay the apparatus they required.

THE idea of establishing an International Hydrographic Bureau was suggested some years before the war, and the project took definite shape when the Admiralty called an International Hydrographic Conference in London in July 1919. Twenty-four of the maritime states of the world were represented and steps were taken to establish a permanent bureau. A committee was appointed which, after nearly two years' work, devised an organisation that proved acceptable to the states represented. Captain Spicer-Simson, the secretary-general, gives some details regarding the Bureau in the *Geographical Journal* for April. The aim is to establish close and permanent association between the hydrographic services of various states, to co-ordinate their efforts with the view of rendering navigation easier and safer, and, so far as possible, to obtain uniformity in hydrographic documents. The Bureau is consultative only and has no authority over national hydrographic offices, which remain entirely independent. It will have a collection of all charts and works published by the various hydrographic and other offices, and will collect papers bearing on hydrography and navigation. An important duty of the Bureau will be the collection and distribution of information on the subject of hydrographic surveys and other publications which are being prepared in the various national offices, and it will also undertake the organisation of an International Hydrographic Conference, if possible, every five years. The Bureau is directed by a board, of which the present members are: Vice-Admiral Sir J. Parry, president; Rear-Admiral J. M. Phaff (Netherlands); Captain S. H. Müller (Norway), and Captain G. Spicer-Simson (Great Britain). The address of the Bureau is, 3 rue du Port, Monaco.

THE British Non-Ferrous Metals Research Association has just issued, in its Quarterly Bulletin, a Union List of periodicals of interest for reference on industrial metallurgy. The service provided by 14 libraries in London, Birmingham, and Manchester is clearly indicated, so far as concerns the 118 periodicals which have been selected. Since one of the main functions of the Industrial Research Associations is to serve as distributing centres for scientific and technical information to their members, such a key-index should prove of great value and will doubtless be followed by other bodies for their own special subjects. It may also be taken as an indication of the interest that is likely to be taken in the proposed World List of Scientific Periodicals of the Conjoint Board of Scientific Societies.

MR. HARRY ALLCOCK, in a pamphlet entitled "The Power of the Penny," advocates a system of decimal coinage of which the shilling would be the unit, divided into ten pennies of a new series, each of which would be worth $1\frac{1}{5}$ of the existing penny; in other words, an existing sixpence would represent five of the new pennies. His view is that the present time is specially favourable for a reform of this kind, which would contribute to the reduction of postal and other charges, which have been raised from 1d. to $1\frac{1}{2}$d., to a penny of the new issue. One thing is obvious, that the currency is at present in an unsatisfactory condition requiring the careful consideration of experts, and the possibility of adopting a decimal system might well form part of such an inquiry. Mr. Allcock has not dealt with the question of fractions of a penny. Each of his new pennies would have to be divided into ten smaller coins, representing $\frac{3}{25}$ of the existing penny in value: in other words, the old-fashioned halfpenny would have to give place to a new coin of higher value.

THAT well-known optical toy, the kaleidoscope, is occasionally used to illustrate the principles of reflection and to study symmetrical patterns. A simple modification has appeared under the name of a "patternscope" in which two metallic reflectors and a glass window form the three sides of a hollow triangular prism about 3 in. long and closed at both ends. A number of small curvilinear pieces of celluloid and glass of different shapes and colours are enclosed, which together with their reflections form an endless variety of beautiful patterns which can be seen through the window more comfortably than is possible through the eyepiece of the kaleidoscope, and also can be seen by more than one person at one time. Either end of the prism may be used as the base, each having a different coloured design on the inside and so adding to the number of patterns obtainable. The instruments are sold by Messrs. "Patternscopes," 85 Duckett Road, Harringay, London, N.4.

DR. L. SILBERSTEIN, mathematical physicist of the Research Laboratory, Eastman Kodak Company, has been appointed an associate editor of the Journal of the Optical Society of America.

SIR WILLIAM PHIPSON BEALE, who died on April 13 last, bequeathes, on the death of his wife, sums of 5000*l*. and 200*l*. to the Royal Institution of Great Britain and the Mineralogical Society respectively.

DR. GORDON HOLMES will deliver the Croonian Lectures of the Royal College of Physicians of London, on Tuesdays and Thursdays, June 8, 13, 15, 20, at 5 o'clock, at the College, Pall Mall East. His subject will be: "The Symptoms of Cerebellar Disease and their Interpretation."

AT the anniversary meeting of the Royal Geographical Society held on May 29, the following officers were elected: *President*: Lord Ronaldshay; *Vice-presidents*: Sir Francis Younghusband, Col. Sir Charles Close, Dr. D. W. Freshfield, Lord Edward Gleichen, Sir T. H. Holdich, and Sir J. Scott Keltie;

Treasurer: Mr. E. L. Somers Cocks; *Trustees*: Lord Curzon of Kedleston and Mr. H. Yates Thompson; *Hon. Secretaries*: Dr. A. P. Maudslay and Lieut.-Col. E. M. Jack; *Foreign Secretary*: Sir Maurice de Bunsen; *Members of Council*: Mr. Henry Balfour, Prof. R. Beazley, Sir Sidney Burrard, Mr. Oliver Bury, Lord Chelmsford, Prof. J. Norman Collie, Sir W. Martin Conway, Sir C. L. Des Graz, Sir Henry Galway, Sir Sidney Harmer, Dr. D. G. Hogarth, Col. C. K. Howard Bury, Admiral Sir Edward Inglefield, Mr. P. Lake, Sir Henry McMahon, Prof. J. L. Myres, Capt. C. W. R. Royds, Major-Gen. Sir Frederick Sykes, Brig.-Gen. Sir Percy Sykes, Dr. A. F. R. Wollaston, and Mr. J. M. Wordie.

MESSRS. DULAU AND CO., LTD., 34 Margaret Street, W.1, have just issued a catalogue (No. 93) of second-hand books in zoology offered for sale by them. Upwards of 3000 works are listed under the following headings: entomology and Arachnida; conchology and Mollusca; minor classes; general zoology; Mammalia, fishes, reptiles, etc.; ornithology and oology.

MESSRS. BERNARD QUARITCH, Ltd. (11 Grafton Street, W.1) have just issued a catalogue (No. 370) of important and rare second-hand books on natural history. Upwards of 2000 titles are listed under "General Works" and eleven classified divisions. Mr. F. Edwards (83 High Street, Marylebone, W.1) has just circulated Catalogue No. 431, which is largely devoted to publications of learned and scientific societies, and to works on the topography of the English counties.

Our Astronomical Column.

LARGE FIREBALL.—On May 21, at 12.32 G.M.T., a large meteor was observed by the well-known variable star observer, M. Felix de Roy, at Antwerp, Belgium. The object moved slowly among the stars of Leo, and left a tail of sparks like a rocket. Its path was from $169° + 9°$ to $155° + 18°$. The same meteor was observed by Mr. J. P. M. Prentice, at Stowmarket, and he recorded the path from $203° + 1\frac{1}{2}°$ to $179° + 15\frac{1}{2}°$. The duration was estimated at six seconds. Comparing the two observations the radiant point is indicated at $280° - 33°$ in Sagittarius. The height of the object was from about 60 to 57 miles and the velocity 15 miles per second. The meteor passed over the region from the south-west of Surrey to south of Warwick.

It is possible that the object radiated from Scorpio at $250° - 27°$, and that its height was 60 to 42 miles, but the observations are not quite conclusive, and more data are required.

COMETS.—There is great difference of opinion as to the magnitude of Skjellerup's comet; Dr. Steavenson makes it mag. 9; other observers, mag. 12. The following approximate orbit has been deduced from observations at Heidelberg, Yerkes Obs., and Milan, on May 20, 21, 22.

T 1922, May 19, 22 G.M.T.
ω 1° 15′ 55″
Ω 207 56 17
i 21 19 4
log q 9·94569

EPHEMERIS FOR GREENWICH MIGNIGHT.

	R.A. h. m. s.	N. Decl.	log r.	log Δ.
June 2	9 38 28	36° 34′	9·9638	9·5856
6	10 18 28	40 58	9·9747	9·5680
10	11 4 53	44 39	9·9871	9·5592
14	11 57 13	47 5	0·0011	9·5600
18	12 51 8	48 2	0·0161	9·5695

The comet should be looked for as soon as the sky is dark; its path lies through Lynx (near Alpha on May 30), Leo Minor, and Ursa Major (near Mu on June 6, near Psi on June 10). Mr. G. Merton points out that the orbit closely resembles that of comet 1830 I; identity does not seem to be possible, but the two comets are probably portions of a primitive single comet.

The Annals of Tokyo Observatory, Tom. v., fasc. 5, contains an investigation of the perturbations of Wolf's periodic comet from 1884 to 1918, by M. Kamensky, Director of Vladivostock Naval Obs., who has revised the work of M. Thraen, finding several small corrections, which produce a marked improvement in the comparison with observation. Definitive elements are given for each return, the perturbations by all planets except Mercury, Uranus, and Neptune having been computed. M. Kamensky notes that there will be a close approach of the comet to Jupiter at the end of 1922; "it will experience such large perturbations that it is doubtful whether its seventh return to the sun—provided that it takes place—will be capable of being connected with the six preceding ones by a common system of elements." It is interesting to note that Brooks's periodic comet (1889 V) also makes a close approach to Jupiter this year, about the middle of June.

Lick Observatory Bull. No. 334 contains an investigation by H. M. Jeffers of the orbits of the two components of Taylor's comet, 1916 I, which was discovered at Capetown on November 24, 1915, as a small nebulosity 20″ in diameter, with an eccentric nucleus. On February 9, Barnard found the comet to be double, the two components being 10″ apart; the northern component was at first fainter, but afterwards became the brighter, and remained visible for two months after the southern one had disappeared; the following are the definitive elements found for the two components; perturbations by Venus, Earth, Mars, Jupiter, Saturn have been applied. They are for the equinox of 1916·0.

Epoch and Osc.	Northern Component. 1916, Jan. 21, 0 G.M.T.	Southern Component. 1916, Jan. 21, 0 G.M.T.
M	− 1° 32′ 6″·4	− 1° 32′ 4″·9
ω	354 47 57·7	354 47 21·8
Ω	113 54 10·2	113 54 25·1
i	15 31 40·6	15 31 27·8
ϕ	33 7 29·6	33 6 36·6
μ	557″·274	557″·695
log a	0·535959	0·535740

The linear distance between the components was least at perihelion, when it was 0·000047 astr. unit. Four months later it was 0·000168. It is noted that in the case of Biela's comet the distance was a maximum at perihelion. The elements show some resemblance to those of Daniel's comet of 1909, but identity is not possible. Taylor's comet is due at perihelion about June 13, 1922, but the conditions are unfavourable for observation; it may, however, be detected in the autumn.

The splitting of Taylor's comet does not appear to have been caused by Jupiter; the nearest approach in the revolution preceding 1916 was 1·1 unit, which is scarcely close enough to explain disruption.

Research Items.

KNOTS IN ANCIENT EGYPT.—Miss M. A. Murray contributes to *Ancient Egypt* (Part I., 1922) an interesting article on the representations of various kinds of knots on early Egyptian monuments. It is a remarkable fact that in the early dynasties knots were never represented, but in the Middle Empire, though the same prejudice still existed, there was a movement towards an accurate presentation of the knot, showing that there was a change, and that the old ideas were beginning to pass away. Miss Murray does not propose an explanation of this curious taboo of the knot on the ancient monuments. It may be suggested that it was based upon the use of knots in magic. Among many races, knots, real or symbolical, are used as a magical means of obstructing some special action. Thus the use of knots at marriage is often disapproved. However this may be, the paper, with good illustrations of various forms of knots and their uses, is of considerable interest.

THE PILTDOWN SKULL.—An important contribution to the controversy over the Piltdown Skull was made by Profs. Elliot Smith and Hunter at a meeting of the Anatomical Society held on May 12, when they exhibited a reconstruction of the skull and its endocranial cast. The reconstruction has been made by a careful and minute examination and correlation of the anatomical points of the fragments of the skull. The result confirms generally the reconstructions made by Dr. Smith Woodward and Mr. Pycraft when first the skull was discovered, and agrees in showing the remarkable breadth of the skull and its low capacity, which is, in each case, placed below 1300 c.c. This later reconstruction, however, differs in one important particular. The occipital fragment assumes a more vertical position, with the effect that the skull is brought into closer relation with the skull of the anthropoids. As a result, the cranium falls into complete harmony with the chimpanzee-like jaw, and the paradox which has hitherto been a stumbling-block to the acceptance of the jaw as indubitably belonging to the fragments of the cranium now disappears.

SAND- AND MUD-BINDING PLANTS.—An interesting exhibit is made in Museum IV., at Kew, of plants used for binding sand and mud. Erosion of bare sand dunes and mud flats by wind and tide is so serious in some coastal regions that the services of engineers and forest officers are constantly engaged upon protective work. Violent winds disturb large quantities of sand, the contour of dunes is constantly changing, and sand encroaches upon cultivated land or is piled in positions that interfere with the domestic and business life of the people. Bare mud flats also undergo constant change by tidal action, and adjacent agricultural land is imperilled. Protective work takes the form of barriers to check scour, and the insertion of such plants as are capable of binding sand or mud. After sand dunes have been fixed by low, dense grasses, other plants soon appear, and the forester assists by planting pine trees, thereby changing desert areas into pleasant places of residence. Mud flats that become overgrown with coarse grasses collect debris and, rising gradually above high-water mark, are turned into rich pasturage. The most satisfactory sand binder is "Marram Grass" (*Ammophila arundinacea*) (Kew Bulletin, No. 9, 1913, pp. 363-366, "Marram Grass for Paper-making"), and the best grasses for binding mud flats are species of Spartina. Articles on Spartina in connection with coast erosion appeared in the same journal (No. 5, 1907, pp. 190-197, and No. 1, 1918, pp. 26-31).

ADDITIONS TO THE INSECT FAUNA OF BRITAIN.—Recent issues of the *Entomologist's Monthly Magazine* contain records of several interesting and, in some cases, important additions to the insect fauna of Britain. In the March number, Mr. K. G. Blair mentions the occurrence of the beetle *Carpophilus ligneus*, Murray, in several widely separated localities, ranging from the Isle of Wight northwards to Liverpool. In each case it was discovered associated with merchandise. The species was originally described from Mexico, and has also occurred in Central America, but does not appear to have been noticed hitherto in Europe as a possible pest of commerce, although its congener, *C. hemipterus*, L., is an almost cosmopolitan species affecting dried fruits and other provisions. In the April issue, Mr. H. St. J. Donisthorpe records the beetle *Nebria iberica*, Oliv., which appears to have been confused hitherto with the very common *N. brevicollis*. Dr. G. Enderlein publishes in the May number of that same journal the description of a new genus and species of scaly-winged Psocids, specimens of which came from Crowborough, Sussex (F. J. H. Jenkinson). The insect, which he designates as *Pteroxanium squamosum*, belongs to a sub-family previously known only from New Guinea and Ceylon; the occurrence of a representative in Europe is therefore very remarkable and suggests the possibility that it is not indigenous but has been imported by some means or other. In the same issue Mr. F. W. Edwards describes a new genus and species of gall midge from North Sussex, the early stages of which are passed among bark-encrusting fungi, upon which blister-like swellings are caused. It appears to be the first record of an Cecidomyiid fly producing a fungus gall. Prof. F. V. Theobald, in *Bulletin of Entomological Research*, Feb. 1922, describes a new genus and species of aphid, *Laingia psammæ*, from marram grass and meadow foxtail in Kent. It was preyed upon by numerous ladybirds, particularly the common two-spotted species.

INCREASING THE SENSITIVENESS OF PHOTOGRAPHIC PLATES.—M. Clerc, in his "Paris Notes" in the *British Journal of Photography*, May 19, refers to M. F. Monpillard's success in 1912 in increasing the sensitiveness of autochrome plates about 30 times. The process was also applicable to ordinary plates, increasing their colour sensitiveness as well as their ordinary sensitiveness. The defect of the method was that the treated plates would not keep in usable condition for more than a day at the very longest. Hoping to overcome this difficulty M. Monpillard did not publish the details of his method, but deposited a sealed packet with the French Photographic Society. As he is unable to continue the work, he has now desired the Society to open the packet and disclose the information given therein. The process consisted in adding a small quantity of silver chloride dissolved in dilute ammonia to the mixture of the usual isocyanine and carbocyanine dyes (pinaverdol, pinacyanol, etc.). As soon as the sensitising bath has been used, the liquid that adheres to the plate must be quickly removed with a whirler, and the plate then dried by a rapid current of air.

International Astronomical Union.

THE meeting of the International Astronomical Union at Rome on May 2-10 must be considered an unqualified success. The unique interest of the selected meeting-place was doubtless a useful auxiliary in drawing together so large a number of delegates; upwards of 100 were present, representing England, France, Italy, Spain, Holland, Belgium, Denmark, Norway, Sweden, Poland, Egypt, S. Africa, Australia, New Zealand, Canada, United States, Japan, etc.

The inaugural meeting of the Union at Brussels in July 1919 was mainly occupied with questions of procedure; the way was thereby cleared for more purely astronomical discussions on the present occasion. The main aim underlying these was the co-ordination of various branches of observation and computation, so as to obtain as large an output as possible without waste of energy through unnecessary duplication; there was also consideration of methods of observation and reduction, and of the unification of notation. Much of the credit of the success obtained is due to the presidents of the various committees, who had drawn up careful and thorough programmes, after correspondence with their members; these served as a basis for discussion, and were in most cases endorsed with small changes.

The opening meeting was held in the Campidoglio in the presence of the King of Italy; it was addressed by the Mayor of Rome, the Minister of Public Instruction, the president of the organising committee (Prof. Volterra) and by the presidents of the astronomical and geophysical unions (MM. Baillaud and Lallemand). The subsequent meetings were in the beautiful rooms of the Reale Accademia dei Lincei, Palazzo Corsini. The Union met in full conference at the beginning and end of the meeting; the more important discussions were carried on in separate committees, the conclusions of which were reported to the final meeting of the Union.

A summary of the more important conclusions may be of interest. In the matter of notation the Harvard system of spectra was considerably amplified; the prefixes *c*, *g*, *d* are used to denote super-giants, giants, and dwarfs; *e* to denote the presence of emission lines; *p*, *q* to denote peculiarities tending in the direction of Nova spectra; *s*, *n* denote that the spectral lines are sharp and diffused respectively (*n* was used by Rowland to denote nebulous lines in the solar spectrum); *r* denotes reversal, *i.e.* bright lines with a dark centre; *k* denotes stationary calcium lines.

It is proposed to use Mo, M3, M8 instead of M*a*, M*b*, M*c*, and to drop M*d*, it being suspected that the underlying spectrum in the latter case is not of M type; similarly No and N3 replace N*a* and N*b*. S is used for a new type of red stars, to which R Cygni and R Andromedae belong; Q is used as before for Nova spectra; they are subdivided by the suffices, *a*, *b*, *c*, *u*, *x*, *y*, *z*, in which the absorption spectrum grows progressively weaker, and the bright-line spectrum stronger; in general a star traverses these types in the above order in the weeks or months succeeding the outburst.

Another point of notation decided was that the constellations should be given their Latin names, which has been done in England but not in France. As regards the Carte du Ciel, special votes of thanks were passed to Cardinal Maffi and to the Nizam of Hyderabad for their great assistance in carrying out the astrographic work at the Vatican Observatory and at Hyderabad. Representations were sent to the respective governments concerned, urging the completion of the work of photography and of printing at the observatories of Catania, Melbourne, and Sydney. The progress of work at the other observatories is good or hopeful, though it was much retarded by the war. Prof. Turner reported that the maps of the lunar surface had been completed, and the list of crater-names prepared, but not yet inserted on the maps. M. Lecointe announced that the Uccle Observatory would not continue the distribution of astronomical telegrams after the end of 1922. The offer of M. Strömgren to send them from Copenhagen (as he did for some years after the outbreak of war) was accepted.

The variable star committee met under the chairmanship of Prof. H. Shapley; it is in this section, above all, that co-ordination of work is imperative. It was decided to print several appendices, giving bibliographies of variables, lists of those needing observation, and determining centres of publication for various classes of stars; the Cracow Observatory undertook the preparation of ephemerides of eclipsing variables; attention was also directed to the useful reprints of Father Hagen's charts of the fields of several variables. Regarding the nomenclature of Novae, it was recommended to use the constellation name followed by the year of discovery; the method of giving numbers 1, 2, 3, etc., to the Novae in each constellation leaves a doubt as to which early observations to include; their status as Novae is sometimes doubtful.

It was decided to continue to give the grants in aid of the distribution of wireless time-signals, at least for the next three years. Prof. Sampson, the president of the committee, spoke in support of the great value of these signals both for longitude determinations and for checking the time determinations at different observatories; he discussed these recently, finding that each observatory had frequently a large discordance that remained nearly constant for some time. These discordances were the subject of an interesting debate between the astronomers and geodesists; the latter stated that they did not find these discordances in their field work, and ascribed them to irregularities of refraction due to the walls surrounding the observing room.

The committee on calendar reform reported in favour of continuing the Gregorian calendar, and of omitting one day in each year (two in leap-years) from the weekly reckoning; however, the latter point was not adopted by the general meeting of the Union.

The committee on stellar parallaxes expressed the hope that workers would photograph each parallax field at ten years' interval, in order to determine the proper motions in each element of the comparison stars.

Great praise is due to the Italian astronomers for their excellent arrangements for the meeting, and the help they afforded to the visitors; mention may be made in particular of Prof. Abetti, who showed great skill as an interpreter.

The next meeting was fixed for 1925 (probably in August) at Cambridge, with Prof. W. W. Campbell as president. The Geodetic and Geophysical Union will meet in Madrid in 1924.

The members of the Astronomical Union were received in audience by the Pope on May 10, being individually introduced to him by Prof. Pio Emanuelli, secretary of the Vatican Observatory. The Pope briefly addressed them, expressing the hope that the meeting of so many nations for a common object would tend to the pacification of the world, and that their studies of the marvellous structure of the heavens would lead to increased knowledge of and reverence towards the Creator.

A. C. D. CROMMELIN.

British Science Guild.

MUCH success attended the annual dinner of the British Science Guild, which was held at the Prince's Restaurant, Piccadilly, on May 23, with the president of the Guild, Lord Montagu of Beaulieu, in the chair. After the loyal toasts had been given by him, Sir Arthur Mayo-Robson, in proposing "The British Science Guild," said he was sure that there is a wider and deeper interest among the public in regard to recent scientific work, and this interest would be far greater if only scientific discoverers would put their discoveries into works that were more accessible to the public. In nearly all cases technicalities could be very much modified in description, and it would be a great advantage if some of the wonderful discoveries could be put in plain language. Thinking people of various parts of the Empire are just as anxious to learn of these matters because they see much of the application of science. The Guild would be doing very valuable work if it could establish centres in those distant places. The toast was supported by Commdr. L. C. Bernacchi, who spoke of the appeal which will shortly be launched with the object of raising funds to enable the Guild to carry out its legitimate and laudable aims, the encouragement of research and the application of scientific method to all public affairs.

Lieut.-General Sir Alfred Keogh, proposing "Science and Industry," said it had been the custom to rail at industries as having no appreciation of science, or modern discovery, and of being slow to adapt themselves to new developments. However true this may have been in the past, there is no truth in it now. The leaders of industry are fully alive to the importance of science, and that is due partly to the wonderful work of the Department of Scientific and Industrial Research and the Research Associations which had been formed in connection with the great trades.

Sir Edward Boyle, replying, said that we were faced to-day as never before by political, social, industrial, economic, and ethical questions. We can face them with hopes of success only in the spirit in which men of science have fought disease; that is, if we face them logically, by investigation, by experiment, impartially, thoroughly, accurately; in a word, if we face them scientifically. Prof. Huxley, who was fighting the battles of the Guild thirty and forty years ago, said that science was nothing more than organised common-sense.

The president gave the toast of "The Guests," and referred to the way in which science was solving modern problems. In one direction with which he was associated, the making of roads, we had only just begun to apply the teachings of science. The chemist is just as necessary to-day for making roads, for example, in deciding the proper mixture of bitumen and sand to make the surface or carpet of the road, as he is for making dies, explosives, or medicines. The toast was acknowledged by Principal Ernest Barker, Mr. H. G. Wells, and Mr. F. W. Sanderson.

Mr. H. G. Wells, who was called upon unexpectedly, said that science was to him a thing so great, so all-important, so entirely such salvation as man had before him, that it was with a feeling of irreverence that he found himself talking about it in an unprepared fashion. By science is meant a process of human intellectual energy which is exhaustively and reverently criticised, leading, it is hoped, to action exhaustively criticised before it is exhaustively planned. In that he expressed the whole of his faith, the whole of his belief in human life. An uncharitable person might entertain the view that the Guild had some idea of monopolising science or claiming science for the purposes of the British Empire, but there was something bigger in their minds than that. Science is a great thing which is going to carry human affairs above those levels, and when we think of science and of the Guild, it means that we of the British community hope to contribute our share to the bigger human process, and to play our part to the best of our ability, with no national and imperial aggressiveness, in the huge task of humanity which is involved in the scientific process.

University and Educational Intelligence.

CAMBRIDGE.—Dr. Searle, Peterhouse, has been reappointed University Lecturer in Experimental Physics, Mr. S. Lees, St. John's College, University Lecturer in Thermodynamics, and Mr. F. Lavington, Emmanuel College, Girdlers' University Lecturer in Economics.

The Botanic Garden Syndicate invite the attention of the University to the very critical financial position of the garden. They have received generous gifts to help in restoring the garden to its pre-war efficiency, but unless the income of the garden can be considerably increased drastic steps will have to be taken which must involve a diminution in its educational value.

It is proposed that a site of seven acres belonging to King's and Clare Colleges and lying between West Road and Burrell's Walk should be purchased for the erection in due course of a new library, the present library not being large enough to meet its growing requirements.

LONDON.—The Senate has made the following appointments:—Dr. R. W. Chambers to the Quain Chair of English language and literature, tenable at University College, in succession to Dr. W. P. Ker, resigned.

At the meeting of the Senate on May 24, Dr. R. M. Walmsley took his seat for the first time since his election as Chairman of Convocation in succession to Sir Edward Busk. In this connection a resolution was adopted in the following terms: "That on the occasion of Sir Edward Busk's retirement from the Chairmanship of Convocation the Senate desire to place on record their cordial appreciation of the services which he has rendered to the University during the past thirty years."

Mr. N. B. Jopson has been appointed to the University Readership in Comparative Slavonic Philology, tenable at King's College, and Mr. R. B. Forrester, to the Sir Ernest Cassel Lectureship in Commerce, tenable at the London School of Economics.

A course of four lectures on "Phänomenologische Methode und phänomenologische Philosophie" will be given in German by Prof. Edmund Husserl, professor of philosophy in the University of Freiburg, at University College, on June 6, 8, 9, and 12 at 5.30 P.M. At the Imperial College of Science and Technology (South Kensington, S.W.) Dr. A. F. Holleman, professor of organic chemistry in the University of Amsterdam, will lecture in English on recent investigations on the substitution in the benzene nucleus, on Wednesday, June 7, at 5.15 P.M.

The following lectures will be given by professors of Dutch Universities at the Royal Society of Medicine (1 Wimpole Street, W.1): On Monday, June 12, "Injurious Agents and Growths," by Dr. M. Jansen (of Leiden) at 5 o'clock. On Wednesday, June 21, "The Pathology of Hæmoglobin," by Prof. Dr. A. A. Hijmans van den Bergh (of Utrecht).

Both lectures will be delivered in English. Admission to all the above lectures is free without ticket.

APPLICATIONS for a Mackinnon Research Studentship of the annual value of 300*l.* will be received by the Secretaries of the Royal Society until June 19. The studentship, which is awarded in the first instance for two years with a possible extension, is for the furtherance of natural and physical science, and for original research and investigation in pathology. Particulars and forms of application can be obtained from the Assistant Secretary of the Royal Society, Burlington House, W.1.

APPLICATIONS are invited by the Ministry of Agriculture and Fisheries for a number of research scholarships in agricultural science, each of the annual value of 200*l.* and tenable for three years. Candidates must be honours graduates of a British University with special qualifications in chemistry, botany, zoology, physiology, or economics. The object of the scholarships is to train agricultural research workers, and the work undertaken must be approved by the Ministry. Scholars may be required to spend a part of their time at an approved foreign laboratory or university. Conditions of the award and copies of the form upon which applications must be made are obtainable from the Secretary of the Ministry of Agriculture and Fisheries, Whitehall Place, S.W.1. Nominations for scholarships, which must be signed by a professor or lecturer of a university or college, must be received by July 15.

THE *Chemiker Zeitung* of May 11 reports that Prof. K. Freudenberg is to succeed Prof. Pfeiffer at the Technische Hochschule, Karlsruhe.

IT is announced in *Science* that Miss Kate C. Garrick, daughter of the late Sir James Francis Garrick, for ten years agent-general in London for Queensland, has by her will bequeathed 10,000*l.* to the University of Queensland to found a James Francis Garrick professorship of either law or medicine, as may seem best to the University, in memory of her father.

ON Saturday, May 6, the undergraduates of Aberdeen University concluded a week's "Carnival" on behalf of the local hospitals with a sand-castle competition on the beach and a pageant in the Mitchell Hall. There were 20,000 spectators at the building of the sand castles. More than 3000*l.* was collected in the city and surrounding towns to which artistes were dispatched in the early days of the week.

FURTHER Research Studentships, about four in number, are being offered to university graduates by the Empire Cotton Growing Corporation and the British Cotton Industry Research Association. The studentships are each of the value of 250*l.*, with certain additional allowances, tenable for one year with a possible renewal for a second year. They are intended to provide opportunities for further training in scientific research bearing on plant genetics and physiology, entomology, physics, etc., or in special subjects relating to administration and inspection in tropical agriculture. One studentship is offered for a candidate having special interest in bacteriology. Further particulars and forms of application are obtainable from the Secretary of the Empire Cotton Growing Corporation, Millbank House, Millbank, S.W.1, not later than June 19.

WE learn from *Chemiker Zeitung* of April 22 that Prof. A. Gutbier, Rector of the Technische Hochschule, Stuttgart, has succeeded Ludwig Knorr as professor of chemistry at the University of Jena.

Calendar of Industrial Pioneers.

June 3, 1803. William Reynolds died.—The son of a successful ironmaster at Ketley, Staffordshire, Reynolds invented a method of raising boats from one level to another by inclined planes, with Telford constructed a cast-iron aqueduct at Longden, Shropshire, and in 1799 patented a method of preparing iron for conversion into steel by the use of manganese.

June 3, 1899. John Nixon died.—The pioneer of the steam-coal trade of South Wales, Nixon was born in Durham in 1815 and was trained there as a mining engineer. In 1839 he removed to South Wales and then to France. His observations on the steaming qualities of Welsh coal led to his shipping a cargo to Nantes, and to a contract for the supply of coal to the French Navy, steps which led to the foundation of the great trade in this coal.

June 4, 1907. Sir Charles Mark Palmer died.—The founder of the great shipbuilding and ironworks at Jarrow, Palmer, who was born in South Shields in 1822, was the son of a shipowner. He early became partner in a colliery business, and in 1851 built the first iron steam-collier for carrying coals from Newcastle to London. During the next forty years no fewer than 600 vessels were built at Jarrow.

June 4, 1906. Francis William Webb died.—A prominent locomotive engineer, Webb was an assistant first to Francis Trevithick and then to John Ramsbottom of the London and North-Western Railway, and in 1871 succeeded the latter as chief mechanical engineer, a post he held till 1903. He was a pioneer of the compound locomotive, and in 1881 with the *Experiment* introduced three-cylinder compound engines, and in 1897 with the *Black Prince* introduced the four-cylinder compound engine.

June 6, 1878. Robert Stirling died.—Stirling, who was born in 1790, was for 53 years minister of the parish church of Galston, Ayrshire. Ordained in 1816, the same year he took out his patent for an engine which produced motive power by means of heated air.

June 7, 1884. Richard March Hoe died.—The well-known New York firm of printing-machine makers, Messrs. R. Hoe and Co., was founded by Robert Hoe, an inventor who was born in England in 1784, emigrated to America in 1803, and died in 1833. His son, Richard March Hoe, born in 1812, was the inventor of the high-speed printing press. He devised the means of holding the type on the cylinder, and built machines having ten cylinders and capable of printing 20,000 newspapers per hour. These machines were used in London in 1858. Many improvements were added by Richard Hoe and by his nephew Robert Hoe (1839–1909), who became head of the firm, and it has been said that "to think of 166,000 sixteen-page newspapers printed in an hour, all folded ready for delivery, a feat made possible by the combination of distinct machines, is to think of the name of Hoe."

June 8, 1882. John Scott Russell died.—One of the most eminent naval architects of last century, Russell was born in Glasgow, May 8, 1808. An original investigator, he made experiments on the resistance of water to the motion of floating bodies, discovered the wave of translation, and developed the wave-line system of construction of ships. Removing to London he became secretary to the Society of Arts, and a commissioner of the Great Exhibition of 1851, and established shipbuilding works at Millwall, where Brunel's *Great Eastern* was built. This remarkable vessel, begun in 1854 and completed in 1859, was 680 feet long, 82 feet beam, and of 27,384 tons displacement.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, May 18.—Sir Charles Sherrington, president, in the chair.—T. B. **Wood** and J. W. **Capstick**: The progress of metabolism after food in swine. Using a calorimeter recording electrically the main loss of heat, the resting metabolism of a hog has been recorded at intervals after feeding, varying from a few hours to six days. The excess of the resting metabolism above the basal, at any moment, is independent of temperature, weight, and age of animal. This excess falls off according to the equation $\log y + At = C$, y being the excess, t time since meal, and A and C constants. This equation is identical with Guldberg and Waage's Law of Mass Action, that the rate of decomposition of a substance at any time depends on amount remaining undecomposed. Analysis shows that the excess depends on the pressure in the body of substances resulting from digestion and affecting the rate of metabolism, which are themselves metabolised according to the mass-action law.—J. A. **Gardner** and F. W. **Fox**: The origin and destiny of cholesterol in the animal organism. Pt. XIII.—On the autolysis of liver and spleen. The autolysis of pulped spleen and liver, during periods varying from one day to a month, shows that the cholesterol content remains constant, within the limit of experimental error, and the addition of pure cholalic acid has no effect. Autolytic experiments afford no evidence that these organs are concerned with the synthesis or destruction of cholesterol in the organism.—C. G. **Lamb**: The geometry of insect pairing. Cases of asymmetrical hypopygium found in certain dipterous families, and in other insects would necessarily result if the usual vertical position of pairing was adopted subsequent to a primitive linear position.—G. E. **Briggs**: Experimental researches on vegetable assimilation and respiration. Pt. XV.—The development of photosynthetic activity during germination of different types of seeds. The seedling leaves of Helianthus showed practically full activity immediately after germination, both when light and when temperature were limiting. Other plants showed practically none. In the type showing the lag between germination and development of photosynthetic activity, the seedling possesses a specialised photosynthetic organ separate from the storage organ, while in the other type the same organ serves the dual purpose. Pt. XVI.—The characteristics of subnormal photosynthetic activity resulting from deficiency of nutrient salts. *Phaseolus vulgaris* was grown in a complete culture solution, and in culture solutions devoid of potassium, magnesium, iron, and phosphorus, respectively. The assimilation of leaves from the plants was measured by determining their output of oxygen. Two types of determinations were made: in one the intensity of illumination was so small that light was limiting; in the other, the intensity was increased until assimilation was limited by temperature. Plants grown in normal solution showed greater photosynthetic activity, and in the others the depression was the same when light was limiting as when temperature was limiting. Probably the factor inside the plant involved is the amount of "re-active chloroplast surface." Therefore activity should be sub-normal when carbon dioxide is limiting, a condition for which some evidence exists.

Geological Society, May 10.—Prof. A. C. Seward, president, in the chair.—E. **Garwood** and Miss E. **Goodyear**: The lower Carboniferous succession in the Settle District and along the line of the Craven Faults. Detailed mapping of definite faunal horizons was employed. Two distinct facies can be recognised, the North Country and the South Country types. The whole of the country north of the North Craven Fault belongs to the North Country type. The beds show a deeper water origin than those of corresponding horizons in Westmorland. There is no Bryozoa band, but the Porcellanous Bed which also occurs at that horizon is taken as the base of D_1. The Main Limestone is less fossiliferous than is the case in Wensleydale, while both the *Cyrtina-septosa* band and the Girvanella nodular band are well developed, and constitute admirable horizons for mapping. A second nodular band occurs in the Lower Lonsdalia Bed. The strip of country between the faults belongs, as a whole, to the North Country type, and marks the southern margin of the North-Western Province. The Orionastrœa band forms an important horizon here, and represents the summit of the Hardraw-Scar Limestone round Ingleborough; below it occurs a Bryozoa band. The area is traversed by numerous normal faults trending usually north-westwards and south-eastwards; but, near Ingleton, the beds are repeated on themselves by thrusts. At three places, between the faults, patches of rock belonging to the South Country type occur. The change in the faunas is everywhere accompanied by an abrupt lithological change, which usually takes place along the line of the Middle Craven Fault. There is no evidence that the change was influenced by faulting during Lower Carboniferous times. The "knoll-reef" limestone represents a special type of deposit. The two facies were probably laid down some distance apart, and brought together by thrusting; the patches of rock of the southern type lying between the faults are portions of an overthrust mass from the south which have escaped denudation. The Middle Craven Fault is a normal fault which took place subsequent to the thrusting.—E. J. **Wayland**, and A. M. **Davies**: The Miocene of Ceylon. Arenaceous and calcareous strata of Miocene age are found over an extensive area in the north and north-west of Ceylon, and in a small part of the southern coast, at Minihagalkanda. At the latter place the beds rest upon Archæan rocks. The whole series appears to constitute a cycle of sedimentation, beginning and ending with areno-argillaceous deposits, and consisting mainly of fossiliferous limestones. The fossils consist of Foraminifera, corals, echinoids, and molluscs. The lower horizon of Minihagalkanda is characterised by *Ostrea virleti*, Deshayes, and is dated as Vindobonian (probably Tortonian), while the higher horizon of the northern area contains *Orbiculina malabarica*, Carter, and may possibly be Pontian. The transgression of the sea on the continental area of Southern India and Ceylon is thus contemporaneous with its recession from the Himalayan geosyncline, in accordance with Haug's principle.

Physical Society, May 12.—Dr. Alexander Russell, president, in the chair.—S. O. **Pearson** and H. St. G. **Anson**: Some electrical properties of neon-filled lamps. The lamp is shunted by a condenser and connected in series with a high resistance to a D.C. voltage supply. When cold no current passes through the lamp until the E.M.F. reaches about 171 volts. If the voltage be reduced when the lamp is glowing, current continues to pass until about 140 volts is reached. When, therefore, an E.M.F. of 200 volts is applied, some time elapses while the condenser is charging up to the necessary 171 volts. Then the lamp begins to take current, the current increases, and the voltage across the lamp falls to the limit of 140 volts, when the lamp goes out.

The cycle repeats indefinitely. The arrangement might be used at low frequency for flashing signs, at audio-frequency for telephonic measurements, and at high frequency (up to about 15,000 ~) for radio-signalling.—A. **Griffiths** and W. T. **Heys**: A new apparatus for the measurement of the polarisation capacity of platinum plates in sulphuric acid. Corrections can be made for leakage and self-depolarisation of the cell. It gives results consistent to one or two per cent., and of the same order of magnitude as those obtained by other observers.—Herbert **Chatley**: The molecular forces involved in cohesion. Cohesion may be expressible as a function of molecular masses or of electronic charges. In either case it will also comprise a space-function, and attention may be concentrated on the latter. The r^{-4} law suggested by Sutherland's theory and Van der Waal's rule, would indicate a greater difference in strength than exists in practice between amorphous substances and crystals. The crystal lattice elucidated by Bragg implies a very gradual space-gradient of force as compared with non-crystalline matter. The r^{-4} law is also inconsistent with the Cavendish experiment. Results more consistent with facts are obtained with an r^{-6} law.

Association of Economic Biologists, May 19.—Prof. E. B. Poulton, president, in the chair.—W. **Rushton**: Further contributions to the biology of freshwater fishes. A short account is given of the effects of the effluents from a series of distilleries, a woollen-mill, and from town sewage on the spermatozoa of trout. The life of the sperms is affected, but the eggs can be fertilised in the presence of the effluents. The effects of tree felling on the water supply to a trout hatchery was an increased acidity causing the appearance of a "bloom" on the sides and gills of the young trout, together with a coagulation of the mucus, which resulted in death.—J. H. **Priestley**: The toxic action of illuminating gas on plants. It has been known for many years that the presence of very small traces of unburnt coal gas in the atmosphere may produce a harmful effect upon growing plants under certain conditions. German observers were the first to notice how very sensitive "etiolated" shoots (the shoots of plants grown in continuous darkness) of the pea or potato or many other plants are to the presence of traces of gas. American workers have since extended these observations, and have shown that traces of coal gas in the atmosphere or the fumes from cigarette smoke or smouldering paper might have a very deleterious action upon plants, especially upon such etiolated shoots. Both German and American workers agree that the deleterious effects of coal gas or these other fumes can be traced to the gaseous unsaturated hydrocarbons, such as ethylene, always present in such fumes. If etiolated shoots or roots are placed in an atmosphere contaminated with coal gas or pure ethylene they cease to grow in length and expand in girth instead. These changes in form can be associated with changes in internal structure, notably with the disappearance of the functional primary endodermis. This endodermis forms close behind the growing point in both the etiolated shoot and in the root, and its disappearance seems to account in large measure for the other structural changes and abnormalities of growth seen in plants poisoned by traces of coal gas. The disappearance of the endodermis in the presence of fumes containing unsaturated hydrocarbons can be attributed to the displacement by these substances of the unsaturated fatty acids which normally accumulate upon the walls of the developing endodermis and give this tissue its characteristic properties. The normal leafy stem growing in the light does not develop such an endodermis, and proves relatively insensitive to the presence of these gaseous unsaturated hydrocarbons. These results are of some practical interest in that they suggest diagnostic features by which the occurrence of gas poisoning in horticultural practice may be recognised. The effect is produced by such very low concentrations of ethylene—of the order of one in a million—that although normal British illuminating gas contains very small quantities of ethylene, toxic effects may be produced by traces of the gas too small to be detected by smell. In fact the most delicate test we have for a gas leak possibly consists in the behaviour of etiolated shoots growing in darkness in the contaminated atmosphere. These results may also be of some interest to municipalities interested in the growth of shade trees along urban routes. The gas leaking from the pipes in the soil may be retained around the roots long enough to do damage because of the impermeable nature of the macadam or asphalte of the road surface.

PARIS.

Academy of Sciences, May 8.—M. Emile Bertin in the chair.—The President announced the death of M. René Benoît, correspondent for the section of general physics, and of Sir Patrick Manson, correspondent for the section of medicine and surgery.—A. **Haller** and Mme. **Ramart**: The dehydration of 2-methyl-2-phenyl-1-propanol and of 2·2-dimethyl-3-phenyl-1-propanol. The product varied with the method of dehydration (passage of vapours over infusorial earth at 300°-400° C., action of $SOCl_2$ with or without pyridine). Substituted ethylenes were obtained, the physical and chemical properties of which are given, together with the oxidation products establishing their identity.—C. **Guichard**: The asymptotic lines of surfaces. The study of a particular case.—P. **Montel**: A new theorem of algebra.—J. **Sudria**: A demonstration and the generalisation of Menabrea's theorem.—D. **Riabouchinski**: Some cases of plane movements of fluids round solids with vortices.—Th. **De Donder**: An electromagnetic field comparable with the corresponding gravific field.—L. **Roy**: The electrodynamics of homogeneous isotropic media in repose.—A. **Bigot**: Kaolins, clays, bauxites, etc. Porosity and loss on heating. The loss on ignition of bauxites and kaolins of different origin at temperatures up to 900° C. are shown graphically, and a second diagram shows the changes in porosity of the same materials. M. **Palfray**: Neutral homocamphoric esters and their reduction products.—J. **Froidevaux**: The estimation of ammoniacal nitrogen in nitrogenous organic material, particularly in proteid materials, and their products of hydrolysis. The liquid is treated with a large excess of concentrated caustic soda solution, and the ammonia removed by a purified air stream without heating, with subsequent correction for ammonia formed from the proteid.—A. **Schoep**: Becquerelite, a new radioactive mineral. This is found as a yellow crystalline crust on pitchblende from the Kasolo Mine (Belgian Congo). Its composition is $VO_3 . 2H_2O$.—A. **Gruvel**: The fluvial origin of the bay of Lévrier. The discovery of two species of Potamides proves that the bay of Lévrier is the ancient estuary of a large river.—P. **Thiéry**: The limit of the Bathonian and the Bajocian in Lorraine.—J. B. **Charcot**: The temperatures at different depths in the chasm of Cap Breton. Observations on the variation of the temperature of the sea in the neighbourhood of this gap in the seafloor agree with the views recently put forward by M. Gorceix, but are opposed to the results of P. E.

Dubalen.—Mlle. Yvonne Boisse **de Black**: The Wurmian in the high valleys of the Cère and the Goul (Cantal).—J. **Thoulet**: The distribution of the chalk in deep-sea sediments. A study of the sediments from soundings taken in the region of the Azores and Canaries shows that the depth has little influence on the composition of the deposits arising from Globigerina.—G. **Bertrand**, M. **Freundler**, and Mlle. **Ménager**: The variations in the chemical composition of sea-water and the evaluation of salinity. From determinations of chlorine, calcium, and magnesium in sea-water from the Atlantic and the Mediterranean, the authors conclude that the relative chemical composition of sea-water is not constant.—L. **Mayet**: The Villafranchian fauna of the Chagny Sands (Saône-et-Loire).—J. **Stoklasa**: The influence of selenium on plant evolution, in the presence or absence of radioactivity. Radium emanation exerts a very favourable influence on plant growth, and can (in daylight) neutralise the toxic properties of selenium as dioxide.—F. Lecomte **du Nouy**: The surface equilibrium of serum and of certain colloidal solutions.—P. **Béhague** and J. **Beyne**: Study of the times of tactile psycho-motive reactions in normal man.—L. **Roule**: The ontogenesis of the Scombriform fishes belonging to the family of the Luvarides. The young of this species at first resemble, not their adult parents, but other families (Coryphenides, Lamprides, Stromateides). The metamorphosis is of long duration and the principal changes do not take place in the very young fish, so that the latter might easily be mistaken for individuals of a distinct species.—F. **Ladreyt**: The histogenesis of the basocellular epitheliomas.—H. **Plotz**: Contribution to the study of the culture *in vitro* of the vaccine virus. A rabbit is inoculated with vaccine pulp, and after a suitable interval is bled. Its serum is cultivated *in vitro* in glucose-broth medium. After the fifth passage, the culture fluid inoculated into the skin of the rabbit gives lesions similar to those produced by vaccine pulp. The animals vaccinated in this way are immune to the virus of vaccine pulp.

Official Publications Received.

Agricultural Research Institute, Pusa. Bulletin No. 129: The Preparation of Anti-Rinderpest Serum, using Animals of Moderate Susceptibility as Virus Producers. By W. A. Pool and T. M. Doyle. Part 1: Buffaloes. Pp. 44. (Calcutta: Government Printing Office.) 12 annas.

Annales de l'Observatoire Astronomique de Tokyo. Université Impériale de Tokyo, Collège des Sciences. Tome 5, 5 Fascicule: Recherches sur le mouvement de la comète Wolf. Par M. Kamensky. Pp. ii+65. (Tokyo: Université Impériale.)

Commonwealth of Australia. Institute of Science and Industry. Bulletin No. 22: A Classification and detailed Description of the Barleys of Australia. Being the Second Report of the Special Committee on Seed Improvement. Pp. 33. (Melbourne.)

Diary of Societies.

FRIDAY, JUNE 2.

DIESEL ENGINE USERS' ASSOCIATION (at Institution of Electrical Engineers).—H. F. P. Purday: Marine Diesel Engines.

SATURDAY, JUNE 3.

ASSOCIATION OF TEACHERS IN TECHNICAL INSTITUTIONS (Annual Conference) (at Polytechnic, Regent Street), at 10.30 A.M.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Hugh Allen: Early Keyboard Music (2).

MONDAY, JUNE 5.

ASSOCIATION OF TEACHERS IN TECHNICAL INSTITUTIONS (Annual Conference) (at Polytechnic, Regent Street), at 10 A.M.—J. Paley Yorke: Presidential Address.
SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.

TUESDAY, JUNE 6.

ASSOCIATION OF TEACHERS IN TECHNICAL INSTITUTIONS (Annual Conference) (at Polytechnic, Regent Street), at 10 A.M.—Viscount Burnham: Address.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Percy Sykes: The Foundation of the Persian Empire.

WEDNESDAY, JUNE 7.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section) AND THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF RADIOLOGY AND PHYSIOTHERAPY (at 1 Wimpole Street), at 10 A.M. and 2.30.—Congress of Radiology and Physiotherapy.
ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—Clayton-Greene, D. Harmer, Dr. E. P. Cumberbatch, and others: Discussion on Diathermy in Surgical Practice.
INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—N. Lea: The Performance of a Radio-Telegraphic Transmitter, with Special Reference to the New Installation at North Foreland.—Prof. C. F. Jenkin: A Dynamic Model of Tuned Electrical Circuits.
SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Dr. J. C. Thresh: The Action of Natural Waters on Lead.—Dr. H. E. Annett and M. N. Bose: The Estimation of Meconic Acid in Opium.—Dr. A. F. Joseph and F. J. Martin: The Composition of Cows' Milk in the Sudan.—W. Singleton: The Use of the Daylight Lamp in Volumetric and Colorimetric Analysis.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, JUNE 8.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section) AND THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF RADIOLOGY AND PHYSIOTHERAPY (at 1 Wimpole Street), at 10 A.M. and 2.30.—Congress of Radiology and Physiotherapy.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Very Rev. Dean Inge: Theocracy (3). The State Invisible.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 5.—Dr. D. S. Maccoll: What is Architectural Design?
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—L. J. Mordell: (1) Gauss's Sums and the Law of Quadratic Reciprocity in any Field. (2) The Integer Solutions of the Equation $ey^1 = ax^3 + bx^1 + cx + d$.—J. E. Campbell: The Deduction of the Ground-form of Einstein's Statical Gravitational Field from Gauss's Expression for the Ground-form in Ordinary Two-way Space.—J. L. Burchnall and T. W. Chaundy: Commutative Ordinary Linear Differential Operators.—G. H. Hardy and J. E. Littlewood: Fourier's Series and Power-Series.—Lt.-Col. A. Cunningham: On Pellian Chains.—H. W. Turnbull: On the General Invariant Theory of Quadrics.—J. Vint: Surface Waves on Limited Sheets of Water.—D. K. Picken: The Euclidean Geometry of Angle.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. Gordon Holmes: The Symptoms of Cerebellar Disease and their Interpretation (Croonian Lectures) (1).
OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Joint Conference between Ophthalmologists and Opticians on Spectacle Construction.
CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Dr. H. H. Dale: Chemical and Physiological Properties (Lecture).
OIL AND COLOUR CHEMISTS' ASSOCIATION.

FRIDAY, JUNE 9.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section) AND BRITISH ASSOCIATION FOR THE ADVANCEMENT OF RADIOLOGY AND PHYSIOTHERAPY (at 1 Wimpole Street), at 10.30 A.M. and 2.30.—Congress of Radiology and Physiotherapy.
PHYSICAL SOCIETY OF LONDON, at 3.30.—Visit to the National Physical Laboratory, Teddington.
ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Major Sir Humphrey Leggett: Tanganyika Territory.
ROYAL ASTRONOMICAL SOCIETY, at 5.
MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society).
ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Annual General Meeting.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—J. Barcroft: Physiological Effects at High Altitudes in Peru.

SATURDAY, JUNE 10.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section) AND THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF RADIOLOGY AND PHYSIOTHERAPY (at 1 Wimpole Street), at 10 A.M. and 2.30.—Congress of Radiology and Physiotherapy.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Hugh Allen: Early Keyboard Music (3).

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

TUESDAY, JUNE 6.

KING'S COLLEGE, at 5.30.—Dr. D. Subotić: Influence of Geography on the Economic Conditions of Jugo-Slavia (2).
UNIVERSITY COLLEGE, at 5.30.—Prof. E. Husserl: Phänomenologische Methode und phänomenologische Philosophie (1). (In German.)

WEDNESDAY, JUNE 7.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.15.—Prof. A. F. Holleman: Recent Investigations on the Substitution in the Benzene Nucleus. (In English.)

THURSDAY, JUNE 8.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Prof. W. Bulloch: The Historical Development of the Doctrines of Croup and Diphtheria.
UNIVERSITY COLLEGE, at 5.30.—Prof. E. Husserl: Phänomenologische Methode und phänomenologische Philosophie (2). (In German.)

FRIDAY, JUNE 9.

UNIVERSITY COLLEGE, at 5.30.—Prof. E. Husserl: Phänomenologische Methode und phänomenologische Philosophie (3). (In German.)

SATURDAY, JUNE 10, 1922.

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Biological Terminology.

THE long-drawn-out discussion on biological terminology which has been a feature of the past year's numbers of NATURE has certainly supplied some food for thought. The state of Denmark may not be so rotten as Sir Archdall Reid believes, but no one who shares his enthusiasm for lucidity will maintain that biological terms are as crisp and unambiguous as could be wished. The reasons for vagueness are not far to seek. The first applies to all the sciences: that concepts change their content from age to age while the words remain the same. This applies to chemistry and physics, and even to mathematics; it must *a fortiori* apply to a young science like biology. Fresh facts demand that some alteration be made in the frames in which they have to be included—terms like 'organism,' 'development,' 'variation,' 'heredity.' The terms must remain, but their content requires continual readjustment. Sometimes, no doubt, new terms are needed, but the invention of good terms is a rare gift.

The second reason for biological vagueness is that biologists are not addicted to philosophy, using the word to mean a criticism of categories. Biologists are plain people dwelling in tents; they are not disciplined in methodology and the art of formulation. To many of them it has not occurred that there is any particular difficulty in terms like 'organism,' 'individual,' 'development,' 'differentiation,' 'evolution.' Some of them use the word 'development' in the forenoon and the word 'evolution' in the afternoon, meaning the same thing both times. Others use the term 'variation' in almost as many different senses as Herbert Spencer gave to the word 'force,' or the older economists gave to the word 'value.'

An outsider, reading Sir Archdall Reid's exposure of biology as 'morass,' 'a tumbling-ground for whimsies,' and so forth, may feel somewhat disturbed. Biologists are accused of playing with undefined terms like 'characters,' 'acquired,' 'inherited,' 'innate,' 'transmitted,' and the impression made on the innocent reader's mind is that biology is in a very unsatisfactory state. But things are not so bad as they seem. A term like 'acquired character' has entered the scientific dictionary as a technical term; it is not happy, but it is not ambiguous; every biologist who knows his business uses it in the same sense; it may be dropped—the sooner the better—but it cannot be re-defined; if we use it at all we must use it as Spencer and Weismann did, meaning a structural change in the body imprinted in the individual lifetime as the direct result of some new peculiarity in functional, nutritional, or environmental nurture, and taking such

grip that it persists after the inducing conditions have ceased to operate. It may be advisable to drop the term 'acquired character' in favour of 'somatic modification,' or the like, but there is not in the mind of the competent biologist any confusion whatsoever in regard to what 'acquired character' means. He uses it as he might use a symbol 'A.C.'

It may be of use to try to state in outline the meaning which biologists attach to the terms they use in describing the facts of variation and heredity. When we compare a thousand descendants of two parents of known pedigree (we are evading the difficult question of 'species'), we may find that they are far from being all alike. They may differ from one another and from the norm of the stock to which they belong. These individual peculiarities can be measured and registered, and they might be called 'observed divergences,' 'observed differences,' 'new departures,' and so forth, so as to avoid any question-begging term. They are changes, at any rate, and many biologists apply to them the general word 'variations.'

When we begin to study the observed differences critically, we find that some of them are directly due to nurtural peculiarities. They are novelties due to novel conditions,—of use and disuse, or of food, or of surroundings. This individual has been imprisoned and that one has been overworked; this individual has been starved and that one overfed; this one has been brought up in a cave and that one exposed to the sun. The resulting differences are somatic modifications or acquired characters. They are exogenous, imprinted from without, what Weismann called 'somatogenic,' what might be called dints in colloquial biology. The goldfish kept three years in darkness loses the rods and cones of the retina; the tropical explorer becomes permanently tanned; the peach-trees taken to Reunion became evergreens, though it took some of them twenty years.

Every character is the *product* of hereditary 'factors' and a certain minimum nurture—food, oxygen, water, and a succession of liberating stimuli; but 'modifications' are lasting changes wrought on the body of the individual as the direct result of some peculiarity in the conditions of life. A modification is more than a response to liberating stimuli; it is an imprint, a dint, a parry to a nurtural thrust. The development of the head will only occur within certain limits—the primary conditions of viability; but the racial peculiarities of the skull are in a different category from deformations imprinted before or after birth. Sir Archdall Reid says this is a distinction without a difference. But we think he is making fun of us.

Of course none of these distinctions is absolutely hard and fast, for we are dealing with the complexity of life. Thus it is not easy to draw a firm line between temporary *adjustments* like sunburning, and lasting *modifications* like tanning. On the other side, there are great differences in the degree in which the developmental expression of hereditary 'factors' demands particular nurtural conditions. Up to a certain point the development of the lung of the embryo chick proceeds without functioning—the gramophone of the inheritance continuing to unwind after the spring has been released. But beyond a certain point the actualisation of the hereditary lung 'factors' will not go *unless the chick breathes*. For a short time an embryo rabbit will go on developing outside the mother; which shows that the environmental dependence is not so narrowly limited as one might think. On the other hand, there are several well-known mutations in the fruit-fly Drosophila which never find expression unless there is some particular external condition, such as humidity. As the next generation shows, the primordium of the character is part of the inheritance, but it remains latent or unexpressed.

Now when we add up all the peculiarities that can be reasonably interpreted as modifications and subtract them from the total of observed differences, we get a remainder—variations as opposed to modifications; or, if the term variations has been already used more widely, *germinal variations* as opposed to Lamarck's "*changements acquis*." They occur among individuals *living under the same nurtural conditions*. They arise from within, endogenously, centrifugally; they are 'blastogenic' in Weismann's phraseology; they are expressions of new permutations and combinations among the germinal 'factors,' 'genes,' or 'determinants'; they may be expressions of changes in the constitution of a 'gene' itself. We know very little as to the origin of these germinal variations *sensu stricto*, but there is no confusion in our concept. Then we may proceed further to distinguish quantitative gametogenic fluctuations from qualitative gametogenic mutations, meaning by the former a little more of this and a little less of that (a longer feather, a higher crest), meaning by the latter a discontinuous or transilient variation, such as a laciniate condition in the Greater Celandine leaves or hornlessness of calves in a horned race. But in the present state of ignorance the categories of variation are necessarily very debatable.

The scheme runs thus :—

$$\text{OBSERVED DIVERGENCES}\begin{cases}\text{GAMETOGENIC VARIATIONS}\begin{cases}\text{FLUCTUATIONS}\\\text{MUTATIONS}\end{cases}\\\text{SOMATIC MODIFICATIONS}\end{cases}$$

What terms are used does not seem urgently important; there has often to be a long struggle for existence among

terms. What is important is that biologists understand one another, and, in spite of Sir Archdall Reid, we protest that they do. One expert may say, "I prefer to use the term fluctuations not for slight intergrading variations, but for certain kinds of modifications"; another may say: "What you diagnose as 'fluctuating *variations*' are really 'fluctuating *modifications*,' though I confess I cannot put my finger on the peculiarity in nurture that induces them." Both may be right; both may be wrong; but there is not in either of them any confusion of thought. Prof. MacBride finds evidence of the transmission of acquired evergreenness in peach-trees; we think that the results may have been due to antenatal infection with certain metabolites, for the seed sojourns for a long time in intimate union with the parent. This is a question of interpretation; there is no confusion of thought in regard to the meaning of 'acquired character.'

In his year of letters Sir Archdall Reid discovered so many mares' nests that we cannot get rid of the suspicion that he has been laughing up his sleeve all the time. Since the scientific study of heredity began, with Darwin let us say, it has been clear that words like 'inherit' and 'transmit' are metaphorical, but has any biologist been misled? Heredity, after all, is but a convenient term for the genetic relation between successive generations,—a relation in which the persistence of a specific organisation is secured through the continuity of the germ-plasm, and yet not so rigidly secured as to shut out the possibility of new germinal variations. Except colloquially, the antithesis is not between heredity and variation, but between complete hereditary resemblance and divergence. The inheritance is all that the living matter of the fertilised egg-cell includes in virtue of its strictly hereditary relation. It would not in the strict sense include either a symbiotic alga or an antagonistic microbe.

The vehicles of the specific organisation are 'factors,' 'genes,' 'determinants,' many of which are certainly located in the chromosomes of the nuclei, but there are also extra-nuclear vehicles, *e.g.* organ-forming substances in the cytoplasm. What the genes precisely are remains uncertain; they are the germinal representatives or initiatives of subsequent differentiations; in a few cases already it seems possible to say that a particular gene, *e.g.* one affecting eye-colour in so-and-so, lies about the middle of the third chromosome! A character in the fully-formed organism is usually the expression of several genes, and the same gene may affect several characters. Every biologist agrees with Sir Archdall Reid that the inheritance is made up of factors for characters, not of the characters themselves, for a character is the *product* of nature and nurture. But just as Darwin sometimes spoke, for short, of an adaptation as the result of selection, when he meant, of course, selection acting on successive crops of heritable variations, so it seems unnecessarily purist to insist always on speaking of hereditary factors rather than of hereditary characters. Gerould has shown that conspicuous blue-green caterpillars (of *Colias philodice*) may arise as mutations in a pure race of inconspicuous grass-green caterpillars, and the offspring of the adults into which two blue-greens develop will breed true. But what is inherited is not the coloration of the blood, for that is due to the xanthophyll and chlorophyll of the food-plant. What is inherited is some subtle gene (a nuclear enzyme perhaps) which acts as a decoloriser or inhibitor of the xanthophyll. Yet would it not be a trifle pedantic to insist that the blue-green character is non-heritable.

Whether the specific organisation which persists in the germ-cell lineage can be added to in a definite way by nurtural changes or modifications wrought in the body of the parent, remains a question for legitimate discussion (see, for instance, Mr. Cunningham's interesting "Hormones and Heredity"), but it is not playing the game to say that "there is absolutely no meaning in the neo-Darwinian statement that acquired characters are not transmissible." Some biologists find convincing evidence that a novel somatic modification can affect the germinal organisation in a manner so specific that the offspring show some representation of the acquired character. Others remain unconvinced by any of the evidence that has been as yet adduced. What is wanted is not a rumpus about terminology, but more facts, and more critical interpretation.

Sir Archdall Reid complains that biologists are thirled to a particular classification of characters into 'innate' and 'acquired,' whereas they ought to take a leaf from the physiologist's book. But this is simply another of the windmills at which the Quixotic knight tilts. When thinking along a particular line biologists must distinguish characters as expressions of an intactly persistent germinal organisation, or as expressions of germinal rearrangements—shufflings of the factorial cards, or as dints directly due to peculiarities in nurture, and this does not exhaust the classification *sub specie hereditatis*. But at another time, the biologist is just as open as any physiologist to classifications of characters from other points of view. Are they generic, specific, or varietal; are they adaptive or non-adaptive; are they the outcome of natural selection, or of sexual selection, or of neither; are they exhibited at birth or do they appear in the course of later development (like the curlew's bill); are they activated by hormones or by more general constitutional changes; are they progressive or involutionary, do they illustrate differentiation or de-differentiation? There is no

restricted outlook in the biologist's classification of characters.

Sir Archdall Reid expostulates with biologists for writing down to the 'nature' account what should be put to the 'nurture' account, but the biologists agree with him in *not* keeping two accounts. The mistake of making an antithesis between 'nature' and 'nurture'—two components of one resultant—is not one to which a biologist can plead guilty. But the biologist understands the difference between hereditary nature realising itself in its normal nurture, and hereditary nature being indented by novel peculiarities. It need not be a 'glaring' nurtural peculiarity, as Sir Archdall Reid says,—a minimal change, *e.g.* in salinity, may serve. It must not be supposed, however, that it is easy to distinguish, especially in mammals and seed-plants, between what are antenatal modifications and what are normal expressions of the inheritance. Much is congenital that is not hereditary. If we only knew the wan newt Proteus in the dark waters of the Dalmatian caves, we should surely conclude that the power of producing pigment was not in its inheritance. Yet we should be wrong. The power of producing pigment has not been lost; it expresses itself whenever the Proteus is exposed to the liberating stimulus of light. Similarly, as to various 'specific characters' of animals, *e.g.* parasites, which we know only from one environment, it may be that some of them are purely modificational, like the green of the Colias caterpillars, and imprinted on each successive generation. Further knowledge may show that many characters which we now regard as 'innate' are only 'imprints' on an innate susceptibility or receptivity. But our inability to say 'yea' or 'nay' in regard to such questions is due to our ignorance, not to any confusion of thought.

No doubt Sir Archdall Reid has made many true statements, *e.g.* that, to begin with, the organism and the inheritance are one and the same; that the inheritance consists of potentialities or factors, not of characters; that a specific character is always the product of 'nature' and 'nurture,' which are complementary, not antithetic; that it is not always easy in practice to distinguish the hereditarily inborn from an antenatal modification; that functioning often counts for much in development. But with these statements all competent biologists are in agreement. To a large extent Sir Archdall Reid has indulged in bogey-hunting and in the pastime of re-editing the scientific dictionary and then importing fallacies into biological argument. To accuse biologists of not dealing with realities is as absurd as indicating that Lamarck's first law is not sense. When a man pulls his bow so tightly as all that, he hits nothing.

Elements and Isotopes.

Isotopes. By Dr. F. W. Aston. Pp. viii+152. (London: E. Arnold and Co., 1922.) 9*s.* net.

DR. ASTON'S book on "Isotopes" is very far from being a mere reprint of his published papers; it constitutes a masterly review of all the aspects of the subject with which he deals. As a result, those who are already familiar with the principal papers which have appeared in the *Philosophical Magazine* will find in the book much that is both interesting and instructive. Thus, the author's account of Dempster's alternative form of the mass-spectograph is particularly interesting; and Dr. Aston has rendered a real service to readers who are not specialists by bringing together in one volume all the methods and results of work on isotopes. His summary of the investigations which have been carried out on radioactive isotopes is particularly concise and readable.

The discovery of isotopes, and particularly of isotopes which are not radioactive, has brought into prominence the necessity for considering afresh the definition of an element. In practice two methods have been adopted. In the radioactive series each isotope has been regarded as a separate element, and has been given a separate name and a separate symbol; this practice has arisen naturally in view of the fact that the isotopes, although having the same atomic number, differ not only in their atomic weight, but also in the source from which they are prepared, and in their stability as measured for instance by the half-life period. On the other hand, it is equally in accordance with traditional methods that chlorine, which has been described as an element ever since the appearance of Davy's celebrated Memoir in 1810, should still be treated as an element in spite of the fact that it is now known to contain two isotopes, the atoms of which differ from one another by two units of atomic weight. This alternative view is supported by Dr. Aston, who recommends that all atoms having the same atomic number should be regarded as isotopes of one element, the number of elements being thus limited to 92. Having regard to the fact that inactive isotopes (with the exception of lead) occur in nature in constant proportions, and that the alteration of these proportions is a matter of very great difficulty, it is unlikely that any complications would arise amongst practical chemists if chlorine and bromine were still to be described as elements instead of as mixtures of elements. It is, however, clear that the two alternative usages which have been described above cannot both persist, and that we must either adopt some common symbol and name for each group of radioactive isotopes, *e.g.* for the three radioactive emanations, or adopt some

distinguishing symbol and name for each of the constituent isotopes of chlorine or bromine, *e.g.* as Dr. Aston has suggested, Cl^{35}, Cl^{37}, Br^{79}, Br^{81}, etc.

This subject was discussed at the recent meeting of the Solvay Institute in Brussels, and the latter alternative appeared to find favour among the majority of the chemists who were present. In this connexion it is of interest to notice that the last occasion on which it became necessary to reconsider the traditional definition of an element arose from the promulgation of Dalton's atomic theory. In his "New System of Chemical Philosophy" (Part I., p. 143) published in 1808, Dalton puts forward the conclusion that "the ultimate particles of all homogeneous bodies are perfectly alike in weight, figure, etc." If this statement be applied to the nucleus atom of Rutherford, it would appear that the atoms of a homogeneous element must be alike both in weight and in the configuration of the protons and electrons of which the atom is composed. Modern investigations have shown that it is possible to find, on one hand, isotopes composed of atoms which possess a like configuration of the planetary electrons in the outer domain of the atoms, but which differ in the weight of the nucleus; on the other hand, isobares are known (*e.g.* Ne^{40} and Ca^{40}) the atoms of which are alike in weight but differ in configuration. It is of course possible that, in the future, atoms may be discovered which are alike both in weight and in the configuration of their planetary electrons, but differ in their radioactive properties as the result of a different arrangement of the protons and electrons in the nucleus, giving rise to a sort of nuclear isomerism. One such case has been suspected amongst radioactive elements; but Prof. Piccard, of Brussels, has suggested that this assumption need not be made if the actinium series of radioactive bodies be assumed to have its origin in an isotope of uranium, instead of in the element which gives rise to the radium series.

On this hypothesis *odd* atomic weights may be assigned to the radio-elements of the actinium series, while retaining *even* atomic weights for those of the radium and thorium series; under these conditions isotopic members of the actinium and radium series would always differ in atomic weight and the occurrence of isobaric isotopes would be impossible. Prof. Piccard states that this conclusion is supported by recent measurements made to test the application to actinium of the Geiger-Nuttall relationship between the penetrating power of the rays and the life of the atoms emitting them. There is therefore at the present time no valid objection in regarding as the criterion of a homogeneous element the fact that its atoms must be alike both in "weight" and in "figure" (as indicated by identical atomic weights and atomic numbers) and using this as a basis in constructing a working definition of the element.

Elementary Pure Mathematics.

(1) *An Introduction to Projective Geometry.* By Prof. L. N. G. Filon. Third edition. Pp. viii + 253. (London: Edward Arnold and Co., n.d.) 7*s.* 6*d.*

(2) *Elementary Analysis.* By Prof. C. M. Jessop. Pp. viii + 175. (Cambridge: At the University Press, 1921.) 6*s.* 6*d.* net.

(3) *The School Algebra* (*Matriculation Edition*). By A. G. Cracknell. Sixth impression (second edition). Pp. viii + 456 + lxviii. (London: W. B. Clive: University Tutorial Press, Ltd., 1921.) 6*s.* 6*d.*

(4) *A First Book in Algebra.* By Dr. F. Durell and E. E. Arnold. Pp. v + 339 + xli. (New York and Chicago: C. E. Merrill Co., n.d.) n.p.

(5) *A Second Book in Algebra.* By Dr. F. Durell and E. E. Arnold. Pp. v + 330 + xliii. (New York and Chicago: C. E. Merrill Co., n.d.) n.p.

(6) *Plane and Solid Geometry.* By Dr. F. Durell and E. E. Arnold. Pp. 503. (New York and Chicago: C. E. Merrill Co., n.d.) n.p.

(7) *Plane Geometry: Practical and Theoretical, Pari Passu.* By V. Le Neve Foster. (Bell's Mathematical Series for Schools and Colleges.) Vol. 1. Pp. xi + 229 + xi. Vol. 2. Pp. xii + 230-423 + xi. (London: G. Bell and Sons, Ltd., 1921.) 3*s.* each.

(8) *Plane Geometry for Schools.* By T. A. Beckett and F. E. Robinson. Part 1. Pp. viii + 239 + v. (London: Rivingtons, 1921.) 5*s.*

(9) *Wightman's Secondary School Mathematical Tables.* Edited by F. Sandon. Pp. 96. (London: Wightman and Co., Ltd., 1921.) 6*d.*

(1) THE fact that a third edition has been issued of Prof. Filon's book on projective geometry is a sufficient indication of its usefulness and merit. There is little to record as regards changes or innovations. One would only like to say that while from chapter 2 onwards the book reads fairly plainly, the first chapter is not at all easy reading. Why need the student be frightened off by such an introduction to a subject full of fascination? If a further edition is called for, perhaps the author could see his way to simplify this chapter and improving the illustrations so as to make it more palatable.

(2) A text-book should avoid two extremes: the tendency, on one hand, to include all possible cases that are likely to arise, and all kinds of questions that an examiner is likely to set; and the danger, on the other hand, of presenting the subject-matter of the book in the form of an almost "bald and uncon-

vincing narrative." Prof. Jessop's "Elementary Analysis" is so short that on occasion it seems to err in the direction of the second extreme. Yet it is a very clear and useful account of what the average student needs to know if he is to benefit by further work, where the calculus and the methods of analytical geometry are required. University courses continue to become more and more inclusive, and many students will be grateful to the author for the brief presentation he offers them. The straight line and circle are discussed in about fifty pages, differential and integral calculus occupy about a hundred, and about twenty pages are devoted to the general equation of the second degree and the properties of the ellipse, parabola, and hyperbola. The last chapter is almost tabloid in character.

(3) This, like the other publications of the University Tutorial Press, seems to be just the book required for "learning up" for an examination. Nothing, apparently, is left to chance, and the student who has mastered its contents should be able to defy any examiner to do his worst. On reading this book one feels inclined to exclaim: Did I know all this when I passed the matriculation examination? For a class text-book a shorter book with more emphasis on principles and less on the examination spectre would be preferable: but for private students—and they are more numerous than many suppose—this book has its obvious advantages. In the second edition chapters have been added on indices and logarithms.

(4) and (5) Elementary mathematics is gradually being released from the burden of manipulative skill and the bogey of the examiner. Students are no longer expected to do jig-saw puzzles with mosaics of simple, square, and double brackets, with pluses and minuses peppered about like the charges in the modern chemist's atom. This release is well symbolised in Messrs. Durell and Arnold's two books on algebra, written for American schools. Each book represents a year's course, developed with skill and knowledge of pedagogical methods. In the first book each chapter is divided into two parts, the first for the beginner in his first half-year, the second for revision during the second half-year. It is doubtful, however, whether revision by complete repetition is an ideal educational process. The second book is in two parts, the second being "a reservoir of extra work for bright pupils." The complete course is very suitable for the standard of matriculation.

(6) Messrs. Durell and Arnold's "Geometry" contains a full and competent account of all the pure geometry that is required by pupils of higher schools. The sequence is reasonable, and the treatment is practical although the book is essentially a course on formal geometry.

The subject-matter comprises the usual plane geometry and a rather extensive course on solid geometry. The sphere is dealt with in some detail, and an interesting feature of the book is the brief account of the properties of spherical triangles as regards congruence and area. This is a very desirable innovation that English books might copy with advantage. Spherical figures are of importance in many branches of knowledge and the student must somehow pick up a little knowledge about them: but, like hydrostatics, spherical trigonometry is a step-child of the modern mathematical teacher.

As the authors use algebraic symbols, it would have been an advantage to introduce numerical trigonometrical methods. The historical sketches are rather dull.

(7) Books on practical geometry usually give constructions for a number of geometrical exercises with little justification, if any. Books on formal geometry aim at giving a systematic and logical course on the subject: occasionally a lapse into real life takes place, but the main object is to build up a structure of reasoning based on a few fundamental notions and postulates. Where the theoretical and practical are combined, one usually has the two more or less dissociated. Mr. Foster's idea is to combine the advantages of both the practical and the formal by working them into an organic whole; he tries to inculcate the geometry of the class-room by means of the observation of outdoor and home life. He has achieved considerable success. The separate formal propositions are reduced to a very small number—and this is an advantage. In the two parts already issued the ordinary plane geometry is covered, up to and including proportionality and similar figures. A third part is promised on solid geometry.

(8) Like Mr. Foster, Messrs. Beckett and Robinson make it their aim to combine deductive with practical geometry. They commence with a number of practical constructions without proofs, even such complicated problems as the drawing of common tangents to two unequal circles. The student is then introduced to notions of area and to solid figures, thus completing the preliminary section. Section I. gives the formal geometry of triangles and parallelograms, with exercises from life, mechanics, and physics. In Section II. are given the properties of circles in formal order, while Section III. deals with areas and Pythagoras's theorem. Cartesian co-ordinates are introduced, contours explained, and a brief course on numerical trigonometry completes the first part. It will be interesting to see the second part. Pythagoras's theorem is too late in the book: the student usually feels quite excited about this theorem, and the sooner he gets excited about

geometry, the better. The gradient is too steep in the trigonometrical portion.

(9) Why does Mr. Sandon use the title "Mathematical Tables"? In reality the booklet seems to be intended as a pocket cyclopædia of much, if not all, knowledge. In 96 small pages we get treatises on arithmetic, algebra, mechanics, calculus—gamma functions are also included—astronomy, insurance, geology, philology, chemistry, earthquakes, the Morse code, the size of wall-paper, ship watches and bells, and Suffolk and Essex measures of butter and cheese, to name only a selection. The book may be useful, but the mathematical portions are hopelessly marred by misprints. S. BRODETSKY.

Miscellanea Physica.

(1) *La Loi de Newton est la Loi Unique: théorie mécanique de l'Univers.* Par Max Franck. Pp. iv+158. (Paris: Gauthier-Villars et Cie, 1921.) 12 fr. 50.

(2) *Fluoreszenz und Phosphoreszenz im Lichte der neueren Atomtheorie.* Von P. Pringsheim. Pp. viii+202. (Berlin: J. Springer, 1921.) England, 144 marks; Germany, 48 marks.

(3) *La Physique théorique nouvelle.* Par Dr. J. Pacotte. Pp. viii+182. (Paris: Gauthier-Villars et Cie, 1921.) 12 fr. net.

(4) *Mécanismes communs aux phénomènes disparates.* Par Prof. M. Petrovitch. (Nouvelle Collection Scientifique.) Pp. v+279. (Paris: Félix Alcan, 1921.) 8 fr. net.

(5) *Über Äther und Uräther.* Von P. Lenard. Pp. 56. (Leipzig: S. Hirzel, 1921.) 9 marks.

(6) *Physikalische Rundblicke. Gesammelte Reden und Aufsätze.* Von Max Planck. Pp. iv+168. (Leipzig: S. Hirzel, 1922.) 60 marks.

(7) *Physique élémentaire et théories modernes.* Par J. Villey. Première Partie, Molécules et Atomes: États d'équilibre et mouvements de la matière (Mécanique, Statique des fluides, Chaleur, Élasticité et Acoustique). Pp. x+197. (Paris: Gauthier-Villars et Cie, 1921.) 15 fr.

(1) THE following are the first and the last statements in M. Franck's "loi unique." "Tout volume est composée d'une somme de positif qui est son potentiel et de négatif qui est sa masse. . . . Ces variations de potentiel dans l'éther sont elles-mêmes déterminés directement ou indirectement par l'Esprit." This law "nous supposons capable de tout expliquer"—everything, from the origin of the universe, through Boyle's law, to the constitution of electricity. Such books are the despair of the reviewer. If they are frankly denounced as nonsense, a cry is raised about an obscurantist hierarchy impervious to all new ideas; while a careful analysis of them with a view of discovering whether anything valuable is concealed in the tangled mass of verbiage requires an enormous expenditure of time and labour. We announce therefore that we have not read M. Franck's book, and do not intend to read any book which aims at subverting the foundations of physics unless the author tells us, in terms of its language and concepts, exactly in what respect he finds its conclusions unsatisfactory.

(2) At the other extreme in this miscellany is Dr. Pringsheim's monograph. It is a summary of all important work on phosphorescence and fluorescence between 1908 (the date of the summary in Kayser's Spectroscopy) and March 1921, the experiments being interpreted so far as possible according to Lenard's theory modified and expanded in accordance with that of Bohr. The author's name is a sufficient guarantee of excellence, and it is unnecessary to say more than that the work is worthy of his reputation and of the traditions of German book-production. The book has a special and melancholy interest in that it is the product of the author's internment for five years in Australia, whither he had gone to attend the British Association meeting as a guest of the Australian Government. He is naturally bitter about his treatment, and every one must agree that the incident was exceptionally unfortunate; but alas! war is a succession of unfortunate incidents.

(3) Intermediate between these extremes is M. Pacotte's volume, which is "un essai historique, critique et méthodologique" on the new physics. M. Borel in his preface suggests that nobody has the right to criticise an attempt to compress so much matter within 200 pages who is not prepared to perform the task better himself; and we accept his suggestion in so far as we shall make no attempt to discuss whether, in his capacity as historian, M. Pacotte has always traced the true line of development. But criticism and "methodology" imply a point of view, and it is open to any one to suggest that the point of view is mistaken, without falling under M. Borel's ban; for if the point of view is wrong the book is not worth writing. We have no intention of declaring categorically that it is wrong, for science may be viewed from many standpoints, all of which are equally legitimate. But we think it right to indicate that M. Pacotte's standpoint is not that of the average physicist, nor yet that of the average philosopher; both of them will experience some difficulty in understanding what exactly is the task that M. Pacotte is trying to perform. His standpoint is perhaps more nearly that of the mathematician; but if the book is addressed to mathematicians it is surely a defect

and not a merit that it should be wholly free from mathematical symbolism. However, it is clear that M. Pacotte has read and thought deeply, and if we have to confess that the results of his labours are not very helpful to us, we are most ready to admit that they may be very helpful to others.

(4) Prof. Petrovitch here pursues the suggestive train of thought which he has started in earlier works. He begins with the familiar observation that physical metaphors are used in connection with the most diverse events; thus we speak of the *cooling* of enthusiasm or the *oscillation* of public opinion. Such metaphors indicate that the most diverse phenomena follow tendencies (*allures*) characterisic of mechanics. He seeks accordingly to classify these tendencies into a few well-marked groups and to place all phenomena of all kinds whatsoever within these groups according to the nature of their tendencies. These ideas (of which the briefest outline must suffice here) lead naturally to a scrutiny of the whole range of knowledge; M. Petrovitch's knowledge is wide and, so far as we can test it, accurate; yet he carries it easily. Accordingly his book will appeal to many who are not immediately interested in his epistemological theses.

We are inclined to think, however, that he overrates the importance of the resemblances he studies. Thus he maintains that when he has analysed any phenomenon according to its tendencies and displayed its mechanical analogies, he has explained the phenomenon in the sense used by Kelvin when he said that to explain a phenomenon was to construct a mechanical model of it. Such a doctrine we think might lead to the most dangerous fallacies if applied to psychology and politics; and though M. Petrovitch, confining himself to analysis and not to construction, seems always to stop short of the precipice, he approaches it very nearly and might well lead shallow thinkers over it.

(5) Prof. Lenard has republished in pamphlet form an article which appeared in Stark's "Jahrbuch." It is one more attempt to avoid the principle of relativity and quantum theory, and seems, as usual, to forget that it is impossible to avoid them entirely, because, since they are formal theories in accord with experiment, any other physical theory so in accord must be formally in accord with them. The basic idea of Prof. Lenard's theory is that every body has its private ether, disturbances in a private ether being transferred in some way (undefined) to a primary ether (Uräther) for transmission to a great distance. To those so attached to ethers that the idea is attractive of an infinite number of coincident ethers all moving at any point with different velocities, the idea will probably appeal. But we confess that we see no need for the Uräther; so far as we can see, private ethers would suffice, together with the assumption that each observer can only perceive disturbances set up in his private ether. (Cf. *Phil. Mag.* 19. 189. 1910.)

(6) Prof. Planck publishes here a collection of his semi-popular lectures and essays, partly on radiation and quantum theory, partly on scientific principles. All that he says here will, of course, be familiar already to serious students, while for the general reader books in a foreign tongue are seldom useful. No comment therefore seems necessary; to praise Prof. Planck's work would be impertinent.

(7) Finally, we come to M. Villey's very interesting volume, of which the first part only is published as yet. Its intention is "A ceux qui possèdent déjà les connaissances normalement enseignées dans les traités de physique élémentaire, exposer les mêmes matières sous une forme assez renouvelée pour stimuler leur curiosité et élargir leurs points de vue" and "A ceux qui veulent acquérir ces connaissances en mettant à profit leur loisir, les présenter non sous l'aspect du manuel pédagogique, mais sous une forme plus attrayante et de lecture plus facile." It is the second object which appeals more directly to us and, we think, to the author. It is impossible for a professional physicist to decide definitely how far the aim has been achieved; we must "try it on the dog"; but we are certain that if the author has failed, his task is impossible and that the fault lies not with him but with the audience he is addressing. The book is a model of that simple, lucid, and logical exposition of which the French language—or at least the French people—alone seems capable. Every one, however deeply versed in physics, will find in it something to stimulate his interest and imagination. M. Villey deserves the thanks of all who desire a wider diffusion of scientific knowledge; we hope that an English translation will soon appear—if only somebody can be found with the courage and ability to undertake it.

N. R. C.

Strasburger's Text-book of Botany.

Strasburger's Text-book of Botany. Rewritten by Dr. H. Fitting, Dr. L. Jost, Dr. H. Schenck, Dr. G. Karsten. Fifth English Edition Revised with the Fourteenth German Edition by Prof. W. H. Lang. Pp. xi + 799. (London: Macmillan and Co., Ltd., 1921.) 31*s*. 6*d*. net.

THE last English edition of this well-known text-book was published in 1912, and the appearance of the present volume will be welcomed by the large number of students and teachers who are already familiar with its many excellent features. This edition appears under a new title, as "Strasburger's Text-

book of Botany," to commemorate the original founder of the work. The general plan of the book remains the same. The first part, entitled "General Botany," includes morphology and physiology; the second part, "Special Botany," is also in two divisions, the first dealing with Thallophyta, Bryophyta, and Pteridophyta, and the second with the Spermatophyta.

The division on morphology, which is contributed by Prof. Fitting, has been entirely rearranged and largely rewritten. It now begins with a consideration of the cell, tissues and tissue systems, and then under the heading of "Organography" deals with the external form and internal structure of the members of the plant. This arrangement permits of a logical development of the subject, in which some consideration is given to form in relation to function. It is clear, however, that the subjects included in this divison cannot be adequately treated in the 206 pages devoted to it. Such subjects, for example, as leaf fall, structure of the hypocotyl, and the phylogeny of the vascular system, receive very scanty treatment.

In a new section six pages are devoted to the theory of descent and the origin of new species. It is doubtful whether such a condensed account of this subject will be of value to the student even for examination purposes. It is true that, as in other sections of the book, there are references to the more important publications on this subject, but since both here and in the sub-section of physiology dealing with heredity and variability the references are almost exclusively to German authors, these will be of limited use to the English student.

The section on physiology, by Prof. Jost, is on the same general lines as that in the fourth edition. It has, however, been very carefully revised and brought up to date, and provides an excellent survey of the subject.

In the Cryptogamic section, for which Prof. Schenck is responsible, the most recent additions to the subject have been brought under review. Among the Thallophytes, alternation of generations is described and figured in the Laminariaceæ, and Kniep's work on the Hymenomycetes is included. The treatment of the vascular cryptogams has been much improved by the insertion of the more important fossil forms in their natural positions among the existing families.

The work as a whole presents a comprehensive and accurate account of the subject. Its main defect is that, in including so much within the limits of a single volume, the treatment of the various sections has suffered from undue compression. The book was written for German students and it cannot fully satisfy the requirements of English teachers, since it does not give prominence to those aspects of the subject with which the English School of botanists has been identified. Nevertheless, it has already established itself as a standard text-book, and in its present revised form and at its extremely moderate price it will meet the needs of many different types of student.

R. J. T.

German Monographs on Biochemistry.

Die Biochemie in Einzeldarstellungen. Herausgegeben von Dr. A. Kanitz.

(1) *Temperatur und Lebensvorgänge.* Von Dr. A. Kanitz. Pp. x+175. 54 marks.

(2) *Über künstliche Ernährung und Vitamine.* Von Prof. Dr. F. Röhmann. Pp. vi+150+2 plates. 42 marks.

(3) *Über partielle Eiweisshydrolyse.* Von Prof. Dr. M. Siegfried. Pp. iv+64. 15 marks.

(4) *Die Einwirkung von Mikroorganismen auf die Eiweisskörper.* Von Dr. P. Hirsch. Pp. x+256. 63 marks.

(Berlin: Gebrüder Borntraeger, 1915–1918.)

THE present may be emphatically termed the period of Monographs of Science. The vast accumulation of facts has long passed the bounds prescribed by the general treatises on physics or chemistry, in which it was formerly possible to find a readable and critical treatment of the subject as a whole. These were succeeded by encyclopædic dictionaries, of the type of Beilstein, which, however useful and indeed invaluable for reference, make no claim to be readable or even critical. In all branches of science, however, the demand is insistent for a comparatively brief and comprehensive account of the present state of knowledge, and it is to meet this that the various series of sectional monographs have sprung up. Among the first of these were the admirable monographs on biochemistry edited by Hopkins and Plimmer from 1908 onwards, and in the series now under review we have the German equivalent of these. Originated as late as 1915, comparatively few volumes have as yet been issued, but the promised list of publications indicates, both by the subjects proposed and the distinction of the authors, that they will form a valuable addition to the biochemist's bookshelf.

(1) The effect of temperature on life processes is here discussed in great detail. After a general introduction in which the physical chemistry of the subject is considered the characteristic optimum effect produced in living organisms is fully analysed. A special part follows in which a summary of the literature is made and the data are incorporated in tables, each class of phenomenon, such as the heart-beat, the action of

poisons, the duration of life, etc., being separately discussed. This provides a very valuable compendium of the existing information on the subject. Among the most remarkable results recorded are the enormous values of the temperature coefficient ($Q_{10}=1000-4000$) in many cases of the duration of life, especially among invertebrates. In this connection the suggestive fact must be borne in mind that high values of Q_{10} are also characteristic of the denaturation of proteins and the inactivation of enzymes. These high values are the more remarkable as in the majority of cases physiological phenomena fall into line with ordinary chemical reactions, the rate of which is increased 2 or 3 times by a temperature rise of 10° C., although in many cases the coefficient falls with increasing temperature.

(2) Criticism, especially of the fundamental propositions enunciated in a new and rapidly expanding branch of knowledge, is useful because it prompts the investigator to re-examine the experimental foundations on which he has based his conclusions. In this way Dr. Röhmann's work has doubtless done good service, but the theses which he maintains, that accessory food factors or vitamins have no existence in fact and that "deficiency" diseases such as beriberi and scurvy are due to prolonged and one-sided feeding with "imperfect" proteins, can no longer be seriously maintained. The author's experimental material has already been very carefully analysed and criticised by Osborne and Mendel, who have pointed out in what directions the "purified" diets of Röhmann fell short of the standard which is now known to be required.

Since the date of publication of this book (1916) overwhelming evidence has been produced—largely in this country and America—that Hopkins was fully justified in his original conception of accessory food factors which cannot be synthesised by the animal but are necessary for the proper utilisation of its diet, however complete this may be in the fat, carbohydrate, protein and salts which form its main constituents. Röhmann has turned his face back towards the ideas of the older physiologists and his book remains as a monument beside the path by which the newer doctrine has been reached.

(3) The hydrolysis of proteins by enzymes is a highly complex process, the exact course of which is by no means fully understood. In the present work a full account is given only of the later stages of this decomposition, commencing with the peptones and proceeding downwards through the kyrines to the peptides. The term peptone is often used vaguely to designate various mixtures of the hydrolysis products of protein, often including the albumoses. We are here given an excellent account of the work, largely due to the author, by which the peptones, in the narrower sense, have been isolated from the products not precipitated by ammonium sulphate, and have been characterised by their chemical and physical properties. Their composition varies with their origin but is always relatively simple, although the author hints at the existence of modes of union between their constituents other than the characteristic peptide linkings to which so much importance has been attached in the structure of the proteins.

(4) The physiological importance of many of the bases formed by the action of bacteria on the amino-acids has made them of great interest to the biochemist. English readers have already at hand, in Prof. Barger's monograph on "The Simpler Natural Bases," a work which includes a great part of the matter dealt with by Dr. Hirsch. In the present volume the subject is approached from the point of view of bacterial action and a full account of the products which have been recognised is given. In addition to descriptive matter, practical methods are also included and a considerable amount of attention is given to the physiological properties of the substances concerned. Interesting sections treat of the pathological effects of bacterial products derived from the proteins and of their therapeutic application.

The author also includes a short but suggestive chapter on the relation between these products and various substances of a basic character which occur in animal and vegetable organisms. There is little doubt that many of the latter have been formed from amino-acids by reactions similar to those produced by micro-organisms, if not actually by their active intervention. A copious bibliography is appended to the work.

ARTHUR HARDEN.

Our Bookshelf.

Alumni Cantabrigienses: A Biographical List of all known Students, Graduates, and Holders of Office at the University of Cambridge, from the Earliest Times to 1900. By Dr. J. Venn and J. A. Venn. Part I., *From the Earliest Times to 1751.* Vol. 1, *Abbas–Cutts.* Pp. xxviii + 437. (Cambridge: At the University Press, 1922.) 150*s.* net.

THE President of Gonville and Caius College and his son have undertaken an immense task in the preparation of the volumes, the first of which is under notice. Dr. Venn has by previous work on the archives of his own College prepared himself for this investigation, and it is as much due to him as to the wise rules of Dr. Caius that the Caius records of past members can be described as "much the best of the series." There are 76,000 names dealt with up to the date 1751 covered by Part I., and details have been gathered together from many sources. For instance, John Ward of

Cambridge is shown by an Institution Book to have been appointed a rector in 1673; a visitation of 1677 states that he was ordained priest at Norwich in 1672; the Bishop's Register there states that this ordinand was B.A. of Jesus College; by this he can be safely identified, and the Jesus books give his parentage and birthplace.

Naturally not many details can be given even when available of most of the persons named in the book. The great majority entered the Church; and the Reformation, the Commonwealth, and the Restoration figure largely in the doings of the Cambridge graduates. But other professions are represented, such as physicians and lawyers, and more rarely statesmen and diplomats. Occasionally careers ended in the stake, the block, or in simple outlawry. Amongst names in the present volume that will interest men of science are William Croone, in memory of whom was founded the Croonian lecture; Isaac Barrow, "famous as a mathematician, as Greek and Latin scholar, and above all as a theologian"; Peter Barwicke, Censor of the R.C.P., one of the few doctors who worked through the Plague of London; Licius Bomelius, physician, astrologer, and magician to the Czar, who died in prison; and Henry Cavendish, chemist, physicist, and mathematician, who left a fortune of more than a million. It is greatly to be hoped that Part I. of this work will receive sufficient support to enable Part II. (1752–1900) to be published.

Catalogue of 1068 "Intermediate" Stars situated between 51° and 65° South Declination for the Equinox 1900: From Observations made at the Sydney Observatory, New South Wales, Australia, during the Years 1918–1919, under the Direction of Prof. W. Ernest Cooke. Pp. vii+29. (Sydney: W. A. Gullick, 1921.)

SOMEWHAT novel lines have been adopted in this catalogue. Prof. W. E. Cooke has endeavoured to follow literally the resolutions of the Paris Astrographic Congress of 1909, which divided the stars to be observed into three classes—Fundamental, Intermediate, and Reference—the second class being deduced from the first by differential methods, and in turn serving as standards for the third class, which are to be used to give co-ordinates on the Astrographic Plates. The position of the Fundamental stars in the zone were taken from the Cape Catalogue, 1900, using the proper motions given there. The new Catalogue reproduces their assumed places with mean discordances of $0{\cdot}001^s$ and $0{\cdot}02''$. The probable error of a catalogued position is found to be $\pm 0{\cdot}006^s \sec \delta$, and $\pm 0{\cdot}13''$.

Collimation errors and errors of division are determined in the ordinary way, but all other corrections, including the instrumental ones and those due to clock error, precession, nutation, and aberration, are applied by differential formulæ described in Mon. Not. R.A.S., vol. 79, No. 1. It is claimed that this method facilitates the correction of the catalogue places for any changes in the adopted places of the Fundamental stars. The pivot errors of the circle are given, but have not been applied, as the method of reduction should eliminate them. The transits were observed by the travelling-wire method, except for some faint stars which were observed over fixed wires. A constant correction was applied to these to reduce them to the other system. A. C. D. C.

The Serbian Epidemics of Typhus and Relapsing Fever in 1915: Their Origin, Course, and Preventive Measures employed for their Arrest. (An Ætiological and Preventive Study based on Records of British Military Sanitary Mission to Serbia, 1915.) By Col. William Hunter. (Reprinted from the Proceedings of the Royal Society of Medicine, 1919, vol. xiii.) (Section of Epidemiology and State Medicine.) Pp. 29-158. (London: John Bale, Sons, and Danielsson, Ltd., 1920.) 7*s.* 6*d.* net.

IN this account of the Serbian epidemics of typhus and relapsing fever in 1915, Col. William Hunter makes a very interesting and valuable contribution to the medical literature of the war.

The R.A.M.C. Mission arrived in Serbia at the worst period of an uncontrolled epidemic of lice-borne diseases. Its principal task was not the supply of extra clinical assistance, but the arrest of the epidemic by administrative and sanitary measures. The chief of these measures were the temporary cessation of railway traffic, the suspension of leave from the army, and the introduction of a widely applicable method of disinfection. The author demonstrates clearly the striking effect on the epidemic of both the cessation and the resumption of the movements of people.

By numerous charts and tables a large number of statistics of considerable scientific interest is recorded, and this, with the details given of the sanitary and preventive measures adopted, will be of value to all connected with the prevention of lice-borne and water-borne diseases in dealing with any future outbreaks on the Continent or elsewhere.

Benign Stupors: A Study of a New Manic-Depressive Reaction Type. By Dr. A. Hoch. Pp. xii+284. (Cambridge: At the University Press, 1921.) 14*s.* net.

AUGUST HOCH recognised the confusion arising out of the classification of certain functional psychoses as Manic-Depressive Insanity; he therefore set out to show that the elation and depression (from which the name has been derived) are of no more theoretical importance than other moods which characterise the group. The volume before us, edited by Dr. J. MacCurdy after the death of Hoch, is designed to show that the symptom-complex associated with apathy is as distinct as that of mania, and the book introduces the functional psychoses characterised by benign stupor.

The essentials of the stupor reaction are (1) more or less marked interference with activity; (2) interference with the intellectual processes; (3) affectlessness; (4) negativism. These and other symptoms which make up the clinical picture of the benign stupor are discussed in great detail and illustrated by numerous cases. Of particular interest is the peculiarity of the ideational content in its preoccupation with the theme of death, often to the complete exclusion of all other ideas.

A brief chapter is devoted to treatment, and stress is laid on the importance of stimulating the patient to exert as much effort as possible. The book is one of the most valuable contributions of recent years to psychiatric literature, and its editor is to be congratulated on the success with which he has carried out the task laid upon him.

Nerve Exhaustion. By Sir Maurice Craig. Pp. 148. (London: J. and A. Churchill, 1922.) 6*s.*

IN introducing the subject of nerve exhaustion, Sir Maurice Craig makes it evident that he is writing for the general practitioner rather than for the student of psychology. He particularly emphasises the importance of the prevention of nerve exhaustion, which is defined as "a state in which there is undue physical, nervous, or mental fatigue." The author considers that the essential factor leading to such a state is "hypersensitivity," which may be physical or psychical, and the recognition of which may enable one to prevent the onset of nerve exhaustion.

It follows from the definition that the condition has a very wide etiology and symptomatology, each of which is discussed under numerous headings. A separate chapter is devoted to sleeplessness and to the individual hypnotics which are used in the treatment of insomnia, but there is no mention of bromural, which is a safe and efficient sedative for most of the milder cases.

In the last chapter it is urged that the treatment of mental disorder should be freed from the legal restrictions which hamper it—restrictions which may have been necessary many years ago, but are now obsolete. The author considers that there are numerous cases of functional nervous disorder which should be allowed institutional treatment without the necessity of being certified, and he instances strong evidence in support of this.

The book will be of considerable value to the practitioner in the recognition and treatment of minor functional nervous disorders.

Guide to the Reptiles and Batrachians exhibited in the Department of Zoology of the British Museum (*Natural History*), Cromwell Road, London, S.W.7. Third edition. Pp. 56. (London: British Museum (Natural History), 1922.) 1*s.*

THIS publication is intended more for the general public than for the student of zoology. The author, whose name does not appear, has obtained a good balance in the treatment of the different groups of animals with which the little book deals. Exception must be taken to the statement that the Opisthoglypha, or back-fanged snakes, are, although poisonous, not dangerous. This is not always the case: the South African boomslang, *Dispholidus typus*, for instance, having in recent years been proved to be an extremely dangerous snake, there being more than one record of its bite having caused death in man. Experimentally it has been shown that the boomslang is more venomous than the cobra, puff adder, or any other justly dreaded South African snake.

Excellent in so many respects, it is a pity that so little pains have been taken in the correction of the proofs, some of the sentences, owing to lack of punctuation, being almost incomprehensible. This little guide, which is profusely illustrated by photographs of specimens in the museum, and by illustrations reproduced from the Cambridge Natural History, is, however, well worth the shilling asked for it.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Rat and its Repression.

I HAVE read with great interest the very able and exhaustive article by Mr. Alfred E. Moore in NATURE of May 20, p. 659, on the rat and its repression. As I have taken great interest in the question of rat suppression, I should like to add a few words to what Mr. Moore says.

If the campaign against these vermin were in such hands as his we should go a long way towards exterminating them, but the public does not take sufficient interest in a matter which they always think affects other people more than themselves. The result is that where one man makes a raid against his rats, twenty do nothing to suppress them, and perhaps ten others actually encourage their propagation by the carelessness with which they leave food and consumable stores unprotected.

One could have hoped that the Ministry of Agriculture would have taken up the matter seriously. The amount of damage done to food-stuffs is incalculable. Not only do rats raid our storehouses, but they also attack the crops almost before they are sprouting in the ground. Those who know Norfolk and Suffolk and any grain-growing district are familiar with the squeals of rats nesting in the hedgerows as they go along the roads, and when the seed-corn has been planted fields are covered with well-worn rat tracks, from which these rodents start to grub up the seeds from the ground and devour them. In December and January every field is covered with rat scratchings, which means that so much corn has been devoured. The loss to the farmer is very great and, of course, the public participates in this.

Piecemeal suppression is of little use, as rats are great travellers, but if a sufficient effort were made by the Ministry of Agriculture to stir up local authorities and to provide some funds, which would not amount to very much, to help them, we should have a remarkable result in the clearing from our fields and our food stores of these destructive vermin. The Treasury will sanction millions for unproductive expenditure. Any minister can get practically what he wants for his own particular hobby, but in this matter of real usefulness where capable local administration is at hand, our custodians of the public purse refuse to assist in any way.

Individual philanthropists cannot be expected to find money for a public cause when the representatives of the public stand idly by. What remedy have we for this? Only one; which is that we should put pressure locally upon our parliamentary representatives and send up communications to the Ministry of Agriculture, urging upon them the necessity of some sort of action.

I hope this advice will not fall upon barren ground. There are plenty of men in both Houses of Parliament who will be very glad to help in pushing this agitation forward.

ABERCONWAY.

43 Belgrave Square,
London, S.W., May 24.

The Blue Flame produced by Common Salt on a Coal Fire.

The blue flame produced by sprinkling salt on a glowing coal fire is a good example of common knowledge, which, not finding a niche and an explanation in text-books, becomes a recurrent topic of inquiry and discussion in scientific journals. It may perhaps be of interest if I add a historical note to what Prof. Merton has stated in Nature of May 27, p. 683.

The blue flame in question appears to have been first treated from the spectroscopic standpoint by the late Dr. J. H. Gladstone in 1862 in a letter to the *Philosophical Magazine* (ser. iv., vol. 24, p. 417). Without being quite conclusive he seems to have regarded copper chloride as the source. The matter was raised again by an anonymous letter to Nature in 1876 (vol. xiii. p. 287), and a discussion has recurred from time to time in these columns from that date until 1890. Full references to this are to be found in Kayser's "Handbuch der Spectroscopie," vol. v. p. 391. A communication to Nature by T. N. Müller in 1876 (vol. xiii. p. 448) seems to have hit the mark. He recognised the flame as being like that of copper chloride, and, surmising that the source of the copper lay probably in the pyrites of the coal, found that the blue flame did not appear when salt was sprinkled on a glowing fire of charcoal. The matter was clinched by Salet in 1890 (*Comptes rend.* 110, p. 282), who identified the spectrum with that of copper chloride as carefully mapped by Lecoq de Boisbaudran, and he actually isolated metallic copper from the fuel ash.

The blue flame given by salt always seems to me distinguishable from that of carbon monoxide, and appears very bright by contrast with the yellow-red glow of the fire. It is somewhat surprising to see how far the yellow sodium flame is suppressed.

Arthur Smithells.

The University, Leeds, May 28.

Optical Resolving Power and Definition.

In Nature of May 27, p. 678, Mr. A. Mallock suggests as a quantitative measure of "definition" in an optical instrument "the angular or linear size of the field of view compared with the smallest corresponding quantity which can be clearly distinguished," and proceeds to extend "definition" on an equivalent general basis to a number of other instruments.

Whether or not this proposal will serve a useful purpose in other directions need not be discussed here, but in the case of optical instruments the measure proposed will not commend itself to opticians, for it involves a radical change in the accepted meaning of "definition" in this connection. The suggestion in fact amounts to nothing more than the measurement of the angular field of view in terms of a unit which varies with the aperture of the lens and the wave-length of the light which is used, a proposal which surely carries its own condemnation in its enunciation. That the ratio in question is worthless as a measure of "definition" is obvious from the consideration that in many instruments, at say the centre of the field, the resolving power and the "definition"—that is the degree to which details of an object are clearly discernible in its image—may remain unaffected while the field of view is greatly changed by an alteration in the size of a suitably placed stop. Conversely in apparently similar instruments the "definition" may vary appreciably from one instrument to another while the field of view and the resolving power are alike in all cases.

The distinction between resolving power and definition is real but not easily defined in a few words. The former deals with the discernment of separate sources of such apparent minuteness that it cannot be claimed that the image indicates with any accuracy the shape of the source itself. The latter is concerned with the sharpness of the apparent image outline of larger objects. The former depends primarily on the dimensions of the first dark ring in the image of an apparently point source, and the conditions of observation require the range of wave-lengths of light forming the focussed image to be limited. The latter depends more upon the broad light distribution in the diffraction pattern than upon the alternations of light and darkness, and the range of wave-lengths is not an important factor. As the size of the rings is not greatly affected by small amounts of aberration, the resolving power is not a suitable measure of the correction of a lens system, but it is precisely upon the degree to which aberrations are removed that definition depends. Of two photographic lenses with the same resolving power, and the same field of view, one may give brilliant pictures because the definition is good and the other comparatively flat pictures because the definition is poor. To the user of simple instruments definition is of great importance, resolving power does not concern him.

This is not a suitable occasion on which to discuss the measurement of "definition" or the standards which are suitable for application to various types of instrument. The subject is one of great difficulty particularly in view of our ignorance of the extent to which it is possible to eliminate aberrations in systems of simple construction. Lest, however, readers of Nature should be misled it cannot be too emphatically stated that in omitting from "definition" its most essential factor and substituting therefor an independent conception, Mr. Mallock's attempted generalisation is likely to prove only a cause of confusion to those who hope to measure the merits of optical instruments by its means.

T. Smith.

The Difference between Series Spectra of Isotopes.

Prof. P. Zeeman mentioned to me recently some new measurements of the absorption spectrum of lithium which he undertook in order to prove the presence of both isotopes. It seems to me, that at the present time it is not certain what one should expect here theoretically. Bohr's formula for the change in the frequency ν due to the motion of the nucleus has been applied by him only to the cases in which a *single electron* moves around the nucleus; namely, to H and He^+. Recently the formula has been also applied by various authors (see F. W. Aston, "Isotopes," p. 123—London 1922) to the calculation of the difference between series spectra of isotopes; this means to atoms in which *several electrons* move around the nucleus. So far as I know there are as yet no investigations on the equation which must for these cases replace Bohr's equation

$$\nu_2 : \nu_1 = \frac{M_2}{M_2 + m} : \frac{M_1}{M_1 + m} \quad . \quad . \quad . \quad (1)$$

(M_1, M_2, m are respectively the masses of the nucleii of the isotopes and of the electron; ν_1, ν_2 are the frequencies of corresponding lines).

In the case of one electron only, (1) follows immediately from the well-known transformation of the "problem of two bodies" from absolute to relative co-ordinates (see, *e.g.*, Whittaker, "Analytical

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Dynamics," § 46). For several electrons there is no similar simple transformation. The "radiating" electron compels the remaining electrons to execute motions of reaction, which also influence the nucleus.

Probably it will be possible to derive a sufficiently approximate formula for the case of the p- and d-motions of lithium. This must be very difficult, however, for the case of the 1·5 S-path. The fact that at all events equation (1) cannot be true in general for atoms with several electrons will be shown by the following example (though of course on account of the Principle of Correspondence not representing a process really occurring in nature): two electrons move around the nucleus in a centrally symmetrical configuration, at first in a two-quantum and then in a one-quantum circle. By symmetry the nucleus remains continually at rest. In this case therefore the liberated energy and, consequently, the radiated ν would, contrary to (1), be exactly independent of the mass of the nucleus. P. EHRENFEST.

The University,
Leyden, Holland.

I SHOULD like to add a few remarks to the interesting letter of Prof. Ehrenfest about the contents of which he was so kind to inform me before publication. As pointed out in his letter, the effect of the mass of the nucleus on the spectrum of an atom, containing more than one electron, is a complex problem which depends on the electronic arrangement in the states of the atom, involved in the emission of the lines, in a way which has hitherto not received sufficient attention. Not only may the mass effect disappear completely in such cases, where several electrons move round the nucleus in equivalent orbits, but, as indicated by Prof. Ehrenfest, this effect may also in case of the motions which we actually meet in the emission of the series spectra be different from that calculated for an atom with one electron.

Although in the emission of these spectra we are concerned with motions whereby a single electron moves in an orbit different in type from the orbits of the other electrons, the problem differs essentially from the problem of two bodies in celestial mechanics. Thus according to the picture of atomic constitution, outlined by the writer in two letters to NATURE (March 24, 1921, October 13, 1921), we shall assume that the electron connected with the emission of the series spectra, although during the larger part of the revolution it remains outside the configuration of the electrons in inner groups, it will nevertheless in certain states penetrate into the interior of the atom during its revolution. The fact that the electron in the inner loop of its orbit is subject to large forces is of preponderant influence as regards the fixation of the energy in the corresponding stationary states of the atom. For such a motion the effect of the nuclear mass might differ essentially from that estimated from an examination of the mechanical properties of the motion in the outer loop only, and the question arises, whether the mass effect is sufficiently large to account for the discrepancies, observed by Merton, in the wave-lengths of certain lines in the spectra of lead isotopes, which although very small are yet much larger than those to be expected from the simple formula quoted in Prof. Ehrenfest's letter.

Although this question seems difficult to settle without a closer investigation, it would scarcely appear probable that the answer will be affirmative. On the other hand, it cannot be excluded that the discrepancies in question are due to a slight difference in the field of force surrounding the nucleus, arising from the difference in the internal nuclear structure of the lead isotopes. This possibility has been discussed from various sides. At first sight we meet with the difficulty, that the dimensions of the nucleus (*ca.* 3×10^{-12} cm.), estimated from experiments on the scattering of α-particles, are exceedingly small in comparison with the dimensions of the orbits of the electron responsible for the emission of the series spectra, which are of the order 10^{-8} cm. or larger.

This difficulty may disappear, however, by considering the circumstance mentioned above, that in certain states the series electron during a short interval of its revolution penetrates deeply into the interior of the atom. In fact, we must assume, that this electron in the states corresponding to the S-terms of the series spectra penetrates to even smaller distances from the nucleus than the electrons in the innermost group of the atom, the dimensions of which are in lead smaller than 10^{-10} cm. To the possible importance of this point in connection with the spectra of isotopes my attention was kindly directed by Dr. Kramers in a discussion about Prof. Ehrenfest's letter. N. BOHR.

University, Copenhagen.

The Destruction of Mosquito Larvæ in Salt or Brackish Water.

A NUMBER of experiments on the destruction of mosquito larvæ by the well-known system of "surface oiling," carried out at Hayling Island during the year 1921, supplied further evidence of the fact that this method is not one of universal application. The production of an unbroken film of a sufficiently lasting nature is sometimes an impossible task, notably in cases where the water surface is broken up by growths of reeds, etc., or is too freely exposed to the wind. In cases of this kind it is necessary to discard the oil film in favour of a "larvicide," that is to say, a substance which, by mixing with the infested water, will destroy the larvæ.

Unfortunately, however, practical information concerning larvicides is difficult to obtain. In the literature of the subject references are to be found to a number of suggested substances, but the vast majority of these stand self-condemned owing to the prohibitive cost that would be entailed by employing them in the prescribed "strengths" on any practical scale. A large number of these larvicides are, moreover, admittedly ineffective when added to brackish or salt water, and are consequently of little value in districts such as Hayling, where the salt-water mosquito, *Ochlerotatus detritus*, is the principal offender.

A number of tests have recently been carried out in the laboratory of the Hayling Mosquito Control, in the hope of discovering a larvicide which could be used successfully (and at a low cost) in salt, or partly salt, water. It was found that a liquid containing 15 per cent of soluble cresol, sold as a disinfectant under various names, gave very promising results in the laboratory. This liquid, at a dilution of 1 in 16,000, was found to kill the larvæ of *Ochlerotatus detritus* in one hour; at a dilution of 1 in 32,000, in one and a half hours; and at a dilution of 1 in 48,000, in three and a half hours. In the majority of these experiments the water containing the larvæ was of a salinity about half that of sea water.

In order to test this larvicide on a larger scale, a shallow stretch of brackish water adjoining the Hayling Golf Links was selected for experiment. This water was very heavily infested with the larvæ

of *Ochlerotatus detritus*, together with a large number of pupæ. Titration experiments carried out by Mr. Lyon Turner showed that the salinity of the water was 49 per cent. that of pure sea water.

After estimating the volume of the water as 20,000 gallons, it was decided to use the larvicide in the proportion of 1 in 16,000, the quantity required being therefore 1·25 gallons. The result of the experiment was entirely satisfactory, a thorough examination on the following day failing to detect a single live larva or pupa. Further examinations were made with the same result on April 26 and May 2, and on May 5 the success of the experiment was further confirmed by an examination made by Mr. P. G. Shute (Ministry of Health Laboratory).

Two other ponds badly infested with the larvæ of *Ochlerotatus detritus*, and containing a large number of pupæ, have since been treated with like success, a thorough examination of both ponds being made on the following day without a single live larva or pupa being found.

It was noticed during the experiments that the addition of the larvicide to one of the ponds in which the water was only slightly saline, produced the characteristic "milkiness" associated with the use of disinfectants of this class. In treating the other ponds where the water was of greater salinity, this cloudy appearance was not produced, although the results obtained in all the three experiments were equally successful. A series of laboratory tests showed that the "milkiness" occurred whenever the proportion of sea water to fresh water was less than 1 in 7, the cloudy appearance being uniformly distributed through the water treated. When the larvicide was added to water of greater salinity, it diffused in the form of minute globules. It was suggested by Mr. P. G. Shute that, in cases where the proportion of sea water exceeded one-seventh, the milkiness (and the accompanying uniform diffusion of the larvicide) might possibly still be produced if the larvicide were diluted with a small quantity of *fresh* water before use. Experiment showed this to be the case, and this preliminary dilution is obviously to be recommended whenever the larvicide in question is to be added to water of appreciable salinity.

It is probable that successful results will be obtained with even smaller proportions of the larvicide than those employed up to the present, since the effects produced with dilution of 1 in 48,000 indicate that the limit has been by no means reached. Further experiments in this direction are now in progress.

It is important to note that water treated with this larvicide in the proportions mentioned is quite harmless to human beings or animals drinking it accidentally.

The comparative cost of "larviciding" and "paraffining" in any given case depends, of course, upon the depth of water to be treated. In cases where the water is shallow there is little to choose as regards expense, even when the larvicide is used in as large a proportion as 1 in 16,000. If d be the depth of any particular sheet of water in inches, n the "dilution" (or the number of parts of water which can be treated by one part of the larvicide), and c the ratio of the cost of the larvicide to that of paraffin, then the ratio of the expense of "larviciding" to that of "paraffining" has been shown by Marshall (*Science Progress*, January 1922, p. 468) to be given by the expression

$$(1500 \times c \times d)/n.$$

In the case of the first pond referred to above, d was 3 inches and n was 16,000. The price of the fluid was 5*s*. 9*d*. a gallon, so that c may be taken as 4. Hence the relative cost of the operation, compared to paraffining, was

$$(1500 \times 4 \times 3)/16,000, \text{ or } 1·125,$$

the actual cost of treating the 1420 square yards of pond being about seven shillings. It should be noted, moreover, that as the water surface in this case was much exposed to wind, paraffining carried out on previous occasions had proved quite ineffective.

Since a cubic yard is the space occupied by 168 gallons, it will be found that the number of gallons in any piece of water is $(A \times d)14/3$, where A is the surface area in square yards and d is the depth in inches. So that, if the larvicide is to be used in the proportion of 1 in n, the number of gallons required will be $14/3(A \times d)/n$ gallons. This is a useful formula for calculation, particularly when a definite value of n has been decided upon for treating a number of ponds.

JOHN F. MARSHALL.
Seacourt, Hayling Island, Hants.

The Teaching of Natural History in Schools.

IN an article which appeared in NATURE, May 13, p. 628, dealing with the memorandum of a British Association Committee on this subject, the following statement occurred: "It devolves on the teachers of zoology to show in detail the kind of zoological syllabus that can be put into operation in schools as a basis for zoological teaching." May I be allowed, as one whose privilege it has been to teach zoology to some hundreds of boys, to offer one or two suggestions for such a syllabus?

The writer of the article was entirely favourable to the spirit of the memorandum, as indeed are a great number of persons responsible for the direction of education. With regard to the younger generation, the learners, the question is answered with no uncertain voice. I have put the choice of zoology or botany to forms of boys of all ages from 14 to 18, and have found invariably that 90 per cent. or more vote for the teaching of zoology. It may be that the boys scent my personal leaning towards zoology (though I try to be impartial) or, again, that they regard the study of animals as a more masculine pursuit than the study of plants. At the same time, it is evident that the boy's mind shows a genuine thirst for a knowledge of animal life.

There are two aspects of the application of zoology to the school curriculum. On one hand, there are the older boys who are being trained for some definite profession—medicine, agriculture, biological research, and so forth. On the other, there are large numbers of younger boys, very few of whom will ever require zoology as a professional subject, who are being taught biology as part of their general education. Zoological syllabuses for the professional examinations are issued by the various universities; moreover, in the Higher Certificate Examination zoology may be offered as a group subject. Thus, in the case of senior boys the biology master has ample guidance in the general requirements of a zoological education, and can develop and extend his teaching accordingly; but in teaching zoology to younger boys the master has to evolve his own syllabus and to form his own standard of attainment. It is with the latter aspect of the subject that I propose to deal.

The boy of fourteen when he comes to the study of biology requires something more substantial than

what is generally implied by "nature study." He is perfectly capable of appreciating the elementary conceptions of anatomy and physiology. He is, moreover, fully alive to questions of sex, and is ready to assimilate a clean scientific view of its meaning. Personally I should find it very difficult to teach either botany or zoology apart from one another to these young boys.

Botany may be offered as a subject both for the Lower and School Certificates; but there is no indication from higher authority as to what should be included in a course of zoology for boys of this standard. It has been necessary, therefore, to substitute special syllabuses in biology of our own making, in order to enforce the inclusion of zoology in the examinations. Two examples are quoted below of the zoological content of biological syllabuses for the Lower Certificate:

A. Boys of 14½-15½, working four hours a week for three terms.

Elementary outlines of anatomy of following: Earthworm, Frog, Rabbit.

Prevention and destruction of insect pests, Elaters (wireworms), Tipulidæ (leather jacket), Aphididæ (woolly aphis).

Special scheme of Research Work.

(*a*) British Bird Life: (i.) Embryology; (ii.) General Anatomy of Birds. The mounting of specimens, examination of beaks and crops in connection with cultivation.
(*b*) Coleoptera, Lepidoptera, Hymenoptera.
(*c*) Anatomy of Farm Animals.
(*d*) Diseases of Animals; Blood.
(*e*) Insect Pests of English Fruit Trees.

One group only has been taken by any boy. Special work has been done by the whole form in preparation of charts, recording agricultural operations, bird life, etc., during the different seasons, and meteorological observations taken daily.

B. Boys of 14-15, working two hours a week for three terms.

A general knowledge of the Natural History of animals, with special reference to British forms (*e.g.* Rabbit, Pigeon, Frog, Snail, Butterfly, Spider). The study of pond life.

The general facts of fertilisation, and embryology of the frog and chick.

Use of the microscope for the study of Protozoa and Crustacea, also for parts of higher animals (*e.g.* scale of fish, feather, squamous epithelium from human cheek).

A general idea of organic evolution.

The above syllabuses, and others of a similar nature, have been successfully carried out. They are, however, open to criticism as not being suitable for wide application, especially in schools where monetary considerations constitute a limiting factor. In the absence of a recognised syllabus for a first introduction to zoology, and with a view of showing how the subject can usefully be introduced in any school, the writer has prepared a small text-book, the zoological syllabus of which is as follows:

Frog—External features, mode of life, respiration, alimentation. Development; breeding, segmentation, tadpole life, metamorphosis.
Earthworm—Habitat, mode of life, external features, general dissection, reproduction, soil action.
Fishes—Dogfish and Cod; habitat, mode of life, external features, development. Scales as a means of age-determination.
Arthropods—Crayfish, Bluebottle Fly, Garden Spider; habits, external features, life-cycle. Comparative table and summary of leading characteristics of each class.
Insect Pests—(An introduction to economic zoology.) Cabbage White Butterfly, Winter Moth, Cockchafer, Bean Weevil, Click Beetle (wireworm), Bean Aphis, Crane-fly (leather jacket), Larch Saw-fly.
Skeleton of the Vertebrate Fore-limb—Perch, Frog, Pigeon, and Rabbit. Comparative table.
Elementary conceptions of Variation and Heredity. Evolution.
The Microscope—Its use; suitable objects for observation. The nature of living matter; the cell. (For schools where the microscope is available.)

This syllabus is in close accordance with the general scope of teaching advocated by the British Association Committee, but is so condensed as to be covered by one hour's work a week throughout one school year. Types which, either through their limited distribution or their expense, may be difficult to obtain have been omitted; it is fatal to begin the study of zoology from a book instead of from an animal.

Finally, although a precise syllabus is necessary for the successful prosecution of class work during school hours, the best interests of zoology will never be served by that means alone. The museum and the aquarium must be going concerns, continually renewed and augmented by voluntary labour cheerfully given out of play-hours.

E. W. Shann.

The School, Oundle, May 16.

Every teacher of biology in public schools will naturally welcome both the original memorandum of the British Association and also the article signed F. K. in Nature of May 13, p. 628. The greatest difficulty in the teaching of biology at public schools at the present time is the position of the teacher. Unlike the teacher of so many other subjects the biologist is not turned out more or less a master of his subject, but is just in a position to begin to learn it, and the subject or subjects are so vast that if he is to do his work conscientiously he has a life's task before him. Of course this is more or less true of every other subject, but I think I am not in serious error when I say that a man with a good classical degree probably finds himself sufficiently well equipped to cope with the really intelligent boys of the upper sixth of the average public school.

So vast is the subject of biology, however, that the teacher cannot hope to cope with the really clever boy unless he is a real student of his subject, and even then of course his influence is that of a slightly superior but at the same time a fellow student, and not that of a master.

The teacher of biology, if he is to carry on his work successfully, must have an average knowledge of a great deal besides his text-book of botany or zoology. He must have a practical working knowledge of microscopy, pond-life, marine biology, field botany, including a reasonable knowledge of mosses, lichens, rusts, and other fungi. One knows, of course, that the mind of the average schoolboy is somewhat limited, but there are always a few that are capable of doing really good work, and for such boys the position of the master must be either one of suppression or that of a fellow-student, and one is seriously led to think that too often the work of the teacher is an act of suppression.

To sum up the whole position, a teacher of biology must be prepared to make his subject his life's work. It is lamentable, however, that even in some of the greatest of our public schools there is little room for the progressive student. The chief form of recognition or promotion consists of extra duty, and it is just this extra duty that puts an end to the idea of study. If a man is to teach biology properly he cannot hope to satisfy the demands of the headmaster who looks for a colleague who will take an active part in the games of the school and a commission in the Corps, etc., and yet unless a man does do these things his chances of success in the scholastic world are poor. Of course things are improving and the high standard of work demanded by university scholarships is making the position of the true teacher a more important one.

I do not think, however, that F. K. is quite just when he advocates a vigorous protest against the opinions of examiners. The universities are naturally anxious to get hold of the best boys available, and they are surely the best men to select their material. We know that all examinations are more or less unsatisfactory, but they are the only possible method.

The chief fault lies in the lack of co-ordination between the university and the public school, and this is not altogether the fault of the university.

A. G. LOWNDES.

α-Particles as Detonators.

WHEN an α-particle passes through matter it may be considered that the matter in the proximity of the path of the swiftly moving particle is momentarily raised to a high temperature. Looked at in this light the action of an α-particle may be likened to that of a detonator and it may be possible to detonate a sufficiently unstable substance by the action of these particles. This has been found to be the case with the familiar explosive compound, nitrogen iodide.

The experiment forms a rather striking lecture demonstration. Nitrogen iodide is prepared in the usual way by the mixture of finely ground iodine and strong ammonia and allowed to dry overnight in the open air. On bringing a fairly strong radioactive source (say the active deposit of radium) within 3 or 4 cms. of the compound the iodide explodes. It may readily be shown by the use of screens of suitable thickness placed over the source that the result is due to α and not to β or other rays.

Detonation is not caused by the first α-particle which happens to strike the substance, but seems to be a probability effect. With a button of nitrogen iodide of about 0·1 cm.^{2} area a source of radium-C equivalent in γ-ray activity to about 3 mg. of radium placed 1 cm. away causes the button to explode in about 20 seconds, *i.e.* when between 10^7 and 10^8 α-particles have struck it. Increasing the size of the button or the strength of the source decreases the time necessary. Quantitative measurements are not very accurate, as it is difficult to ensure identical conditions of experiment. Doubtless other unstable compounds might be found which would also be exploded in this manner.

G. H. HENDERSON.

Cavendish Laboratory, Cambridge, May 23.

Active Hydrogen and Nitrogen.

Two brief comments are suggested by the interesting work of Dr. F. H. Newman on the activation of hydrogen and nitrogen described in the *Philosophical Magazine* for March. The failure of the reaction product of the active nitrogen with sulphur, phosphorus, and iodine to give a test for nitrides is not evidence of the absence of a chemical reaction between those elements and nitrogen, for all three are more electronegative than nitrogen and the compounds formed would be sulphides, phosphides, and iodides, respectively. That this is in fact the case is shown in some experiments of mine with Dr. A. C. Grubb, which are now in process of publication, in which tests for sulphides and phosphides were actually obtained after exposing the corresponding elements to a stream of active nitrogen formed in the corona discharge. Our experiments did not include iodine.

Further, the evolution of gas when the bulb, in which these same three elements had been exposed to active hydrogen, was heated from −40° C. to 100° C. is not evidence of the failure of these elements to react with the active hydrogen, for the compounds formed would be hydrogen sulphide, phosphine, and hydrogen iodide, all of which are gaseous at the latter temperature though liquefied at the former, and would thus be evolved in the gaseous form when heated to increase the pressure as noted. Here again my experiments with Dr. R. S. Landauer and with Dr. William Duane, already published, show that phosphine and hydrogen sulphide are actually formed, the latter being confirmed by the dynamic method of Dr. Newman.

GERALD L. WENDT.

Chicago, Illinois, U.S.A.

IN reply to the comments made by Prof. Wendt, although no traces of the nitrides of sulphur, phosphorus, and iodine were found in the experiments on the activation of nitrogen, this was not unexpected, as it was considered highly improbable that any chemical compounds formed would respond to the nitride test. As the absorbed gas was not reliberated on heating, it appeared that chemical combination had taken place, the compounds so produced being very stable. Several other elements actually formed nitrides with the active nitrogen. These two facts suggested that chemical compounds were produced. The experiments of Prof. Wendt, now in the course of publication, seem to confirm this view.

As regards the action of active hydrogen on these three elements, it was found that at temperatures above 0° C., absorption of the gas occurred, although at a decreased rate. At these temperatures, if the chemical products formed are hydrogen sulphide, phosphine, and hydrogen iodide, they must be present in the gaseous state. There are other factors to be considered in order to account for the disappearance of the hydrogen, for the production of these gases will not explain the decrease in pressure. They are probably "trapped" within the solid present in the tube, and only reliberated on heating. Some of the gas which was evolved on the application of heat was re-absorbed when an electric discharge was passed through it, or when exposed to α-ray radiation. This re-absorbed gas was hydrogen, which may have been produced by the dissociation of the chemical compound formed originally, or it may have disappeared originally by occlusion within the solid. Although chemical action does account for the disappearance of some of the hydrogen, other processes, such as occlusion, have to be taken into account.

F. H. NEWMAN.

University College, Exeter.

A Supposed Ancestral Man in North America.[1]

By Dr. A. SMITH WOODWARD, F.R.S.

PROF. H. F. OSBORN has just described a water-worn small molar tooth from a Pliocene formation in Nebraska, U.S.A., as the first evidence of an anthropoid primate discovered in the New World. The specimen was found in the Snake Creek beds by Mr. Harold J. Cook, who has already made known numerous important remains of Pliocene mammals from Nebraska, some showing marked Asiatic affinities. With the aid of Drs. W. D. Matthew, W. K. Gregory, and M. Hellman, Prof. Osborn has determined the tooth to be a second upper molar, and he has named the unknown genus and species to which it belonged *Hesperopithecus haroldcookii*. It is nearly as large as the second upper molar of an American Indian, and its two diameters are almost equal. The kind of wear shown by its evenly concave coronal surface "has never been seen in an anthropoid tooth." In type the tooth is "very distant" from the corresponding tooth of the gorilla, gibbon, and orang; it is "still very remote" from that of a chimpanzee. It is also "excluded from close affinity to the fossil Asiatic anthropoid apes" represented by teeth found in India; and "it cannot be said to resemble any known type of human molar very closely." Indeed, "it is a new and independent type of Primate, and we must seek more material before we can determine its relationships."

The statements quoted make it difficult for one who has not seen the tooth to understand why Prof. Osborn even refers it to a Primate; and the published figures are not very helpful. The crown may be described as nearly triangular in shape, with bluntly rounded angles, a slightly raised and partially crimped rim surrounding a gently concave surface. The root is very massive, and at a considerable distance below the crown it becomes bifid, the smaller portion extended beneath one margin of the crown, the larger portion beneath and inclined towards the opposite apex. On one side of the root, between the bifurcation and the crown, there is an irregular indentation, from which Prof. Osborn supposes a third root-fang has been broken away. No stump of this third fang, however, is shown in the drawing.

In determining the tooth to be an upper molar, Prof. Osborn regards the edge with the smaller portion of root as external, and the tapering opposite end with the larger portion of root as internal. The hypothetically restored piece of root thus becomes posterior. It is, however, equally reasonable to interpret the so-called external border as anterior and the tapering end as posterior. If, then, the indented lateral portion of the root never bore another fang, the tooth becomes a lower molar. If this interpretation be admitted, comparison should be made not with any Primate tooth, but with the last lower molar in the primitive bears. In general appearance and shape the crown is very suggestive of that of the last molar in the lower jaw of some species ascribed to Hyænarctos and related genera; and as primitive bears of this group are already known by several fragments from the Pliocene of North America, material will eventually be available for comparison. The root of the last lower molar of Hyænarctos unfortunately appears to be unknown; but in the modern Ursus, in which the tooth in question is extremely variable, the root is often bifid, as in the new fossil from Nebraska, while between the bifurcation and the crown there is a hollowing of its outer face. There is, indeed, some reason to suspect that Hesperopithecus has received an inappropriate name.

[1] H. F. Osborn, "*Hesperopithecus*, the first Anthropoid Primate found in America," American Museum Novitates, No. 37 (reprinted, without figures, in *Science*, vol. 55, pp. 463-465, May 5, 1922).

Synthetic Dyes as Antiseptics and Chemotherapeutic Agents.

By Prof. C. H. BROWNING, University of Glasgow.

GENERAL interest in this subject has been recently stimulated by accounts in the daily press of a communication to the Society of Chemical Industry at Manchester by Messrs. Fairbrother and Renshaw.[1] The fact, however, ought not to be overlooked that much work has been in the past devoted to these problems by a number of investigators. That certain dyes of the triphenylmethane class possess marked antiseptic properties has long been known. Thus Stilling[2] in 1890 noted the powerful effect of ethyl violet on staphylococci (one of the commonest group of organisms which cause suppuration). He suggested the use of a mixture of allied dyes in the treatment of infective conditions, especially of the eye. But Stilling's suggestion found little favour with practical surgeons. As compared with phenol or mercuric chloride, the antiseptic dye-stuffs in general exert their lethal action on bacteria relatively slowly; thus, when tested by the usual method, in which only a brief period of contact between the organisms and the chemical agent is permitted, these dyes appear to act very weakly. It is probably for this reason that they were neglected.

The fact was overlooked that from the beginning of contact very high dilutions of antiseptic dyes may inhibit bacterial activity and that such "bacteriostatic" action can be utilised advantageously for therapeutic purposes. Churchman,[3] however, in America has investigated more recently the allied product, gentian violet, and has emphasised its value in the treatment of certain local pyogenic infections. The diaminotriphenylmethane dyes, malachite green and brilliant green, were shown to be actively antiseptic by Drigalski and Conradi[4] in 1902, and brilliant green has been applied with success in the treatment of infected wounds.

Investigations carried out with the view of comparing the antiseptic properties of various classes of dyes by Browning and Gilmour[5] confirmed the fact that a considerable number of basic compounds showed

such action; the series of compounds which they investigated included the acridine group, triphenylmethane group, indamines, azine dyes (safranin), thiopyronin, and thiazines (methylene blue). A continuation of this work showed that of all the substances examined diaminoacridine derivatives ("acriflavine" and "proflavine") stand out on account of a combination of three characteristics, namely, high antiseptic potency, low toxicity for mammalian tissues, and insusceptibility to the interfering action of serum proteins, which diminish markedly the efficacy of all other powerful antiseptics hitherto tested. Therefore these substances, the antiseptic properties of which had not been recognised before, have been widely employed for the treatment of localised pyogenic infections, *e.g.* in wounds; when suitably applied, their use has proved highly beneficial. Recently also non-ionised compounds of mercury with dyes of the eosin group have been successfully used in America (mercurochrome of Young, White, and Swartz).[5A] In the case of generalised infections, however, the therapeutic problem is attended by much greater difficulties, and there is probably no synthetic compound so far available which will exert curative action in generalised bacterial infections in the human subject.

SELECTIVE ACTION.

When the antiseptic potency of a series of compounds is determined for organisms of various types, striking instances of selective action are met with, *i.e.* one compound will act very powerfully upon a particular organism and be relatively inert toward another; other compounds may exhibit the reverse order of activity on the same two organisms. Selective action of this kind was noted by Rozsahegyi [6] in 1887. Probably the most striking example of this is exhibited by the cyanine dye, "sensitol red," the ratio of the sterilising concentrations for *B. coli* and *Staphylococcus aureus* being probably greater than 2000 : 1 (Browning, Cohen, and Gulbransen).[7]

RELATIONSHIPS BETWEEN CHEMICAL CONSTITUTION AND ANTISEPTIC ACTION.

Within narrow limits, in groups of closely related compounds, certain laws have been established. In the triphenylmethane series, both with the diamino and the triamino derivatives, the substitution of methyl and ethyl groups in the amino radicals has been found to enhance the antiseptic action. Thus the penta- and hexamethyl triaminotriphenylmethane dyes, methyl violet and crystal violet, have been found by Dreyer, Kriegler and Walker,[8] and others to be more potent against staphylococci than the unsubstituted analogues, rosaniline or parafuchsine; similarly malachite green (the tetramethyl diamino derivative) and brilliant green (tetraethyl derivative) are much more powerful than the unsubstituted diaminotriphenylmethane dye, Doebner's violet.[5] In the acridine and azine series it has been established that potency of action in a serum medium is a characteristic of the diamino derivatives which have an alkyl group attached to the medial nitrogen atom (Browning, Cohen, Gaunt, and Gulbransen).[9] But general principles correlating chemical structure with antiseptic action cannot be formulated in the present state of knowledge. There is certainly no relationship between colour and effect on micro-organisms.

ACTION ON PROTOZOA.

Ehrlich and Shiga [10] discovered that by means of injections of a benzidine dye, which they named trypan red, mice infected with the trypanosomes of the South American horse disease, *mal de caderas*, could be completely sterilised; thereby an otherwise acutely fatal infection could be cured. This work gave the impetus to the search for chemotherapeutic agents, and the greatest success achieved in this line has been the discovery of the "salvarsan" group of compounds by Ehrlich and his co-workers. In this department of research, again, it is impossible so far to enunciate general principles which should guide us in the search for effective substances. The therapeutic action is frequently not simply that of an antiseptic operating in the tissues and circulation of the infected animal; thus *in vitro* the parasites of *mal de caderas* are not killed by concentrated solutions of trypan red. Further, selective action is exhibited to a very marked degree by chemotherapeutic agents in protozoal infections; the efficacy of quinine in malaria and its relative inertness in trypanosomiasis is an instance of this. Certain compounds, however, are lethal for protozoa *in vitro* in concentrations which permit bacteria, of some species at least, to survive. Fairbrother and Renshaw suggest that such substances may be utilised with advantage in circumstances in which the process of bacterial purification of sewage fails, owing, it is believed, to an overgrowth of certain protozoa destroying the bacteria.

The search for chemical substances which shall exert curative effects in bacterial and protozoal infections appears to be well worth pursuing, since there are many diseases in which it would seem to be impossible to influence to a significant extent the natural defensive mechanisms of the body by procedures of specific immunisation; tuberculosis is an outstanding instance. But the successes hitherto achieved, especially in protozoal and spirochætal diseases (quinine in malaria, salvarsan in syphilis and other spirochætal infections, trypan blue in piroplasmosis, and emetine in amœbic dysentery), and the promising results in certain bacterial diseases (diaminoacridine derivatives, triphenylmethane compounds and mercurochrome in local pyogenic infections, and ethylhydrocuprein in experimental pneumococcus infections) are still more or less isolated phenomena. If it be possible to establish general principles in chemotherapy, this result will only be attained by much further investigation.

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The 700th Anniversary of the University of Padua.

By Prof. E. W. SCRIPTURE.

THE university of Padua was founded by professors who migrated from Bologna in 1222 owing to oppressive regulations. It very rapidly became great and famous. For nearly 500 years it was one of the leading universities of Europe.

The development of English culture and religion was strongly influenced by the earlier English students of Padua, comprising Linacre, Latimer, Tunstall, and Pace. English science received a splendid glory by Harvey's discovery of the circulation of the blood, in the anatomical theatre of Padua, and it was the inspiration of great thinkers, like his professors Galileo, Acquapendente and Casserio, that stimulated his active mind to a new thought. Evelyn, one of the founders of the Royal Society, was a student here; at his house many of the influential figures of England appeared. Sherard, who founded the chair of botany at Oxford, laid out the Oxford Botanical Gardens on the model of those of Padua, the oldest in Europe. Dr. Caius, the founder of Caius College, was also a student at Padua.

Viewed as a national university Padua is a brilliant success. Its medical school is excellently equipped. Its faculty includes Luccatelo (medicine), Bassini and Donati (surgery), Belmondo (psychiatry), and Casagrande (hygiene). It has a special school of hydraulics, a subject of such importance that Italy has established a special Ministry for it. Its equipment in geology and palæontology is in some departments unequalled anywhere else. In law it is almost, perhaps quite, the first place in Italy. In history the name of Manfroni at once comes to mind. When it is considered that all the students are post-graduate and professional (no undergraduate), Padua ranks certainly with the best universities of England and America.

The glory of Padua lies in the great men who once taught here, and in the splendid students it produced. It is worth while to inquire concerning some of the causes that produced not only its past greatness, but also that of Paris and Prag.

In the first place, the students of Europe were free to attend any university and to migrate from one university to another. Of course they went wherever they were attracted. At Padua the vast number—at one time 6000—was divided into partially self-ruling divisions according to nations. Padua, like Paris, Prag, Oxford, or Leyden, was a world-university.

The success of a university in attracting students depended on the quality of learning to be found. The best of professors were sought out by Padua; its roll of teachers included men of the rank of Galileo and Vesalius. The faculty, like the body of students, was international. The great mathematician Belmondi was followed in succession by Peurbach, Müller (Regiomontanus), and Paul of Middelburg.

To-day Padua is a purely Italian university. The 3220 students are all Italians, except for 47 foreigners (of whom 9 are Austrians). The Dutch universities ceased to be more than national affairs because Latin ceased to be the international language of learning, and no one would learn Dutch in order to study in Holland. This cannot be the case with Padua, because Italian, like German or French, is a language worth learning. That students will learn a language in order to study in a foreign country is shown by the great numbers of foreigners who studied in Germany before the war. The cause must be sought elsewhere.

Careful inquiry fails to find a single professor of the highest international fame now here, whatever the national reputation may be. This is one of the reasons for the change in Padua.

Students may attend a university on account of itself, regardless of the professors. This is the main force for most universities to-day except in Germany. A man goes to Oxford or Harvard because it is Oxford or Harvard, and not because there may be a famous man in his particular line. This determines successfully the large body of undergraduates as in English universities, but there is no undergraduate instruction at Padua. The principle becomes unfavourable when applied to a *graduate* university, as seen most strikingly in Padua. Its students, mainly from the north of Italy, attend in order to get their degrees, and afterwards their places and appointments. They become good lawyers, doctors, engineers, etc., but they do not receive the training in research and the inspiration toward originality of the olden days. The reflex on the university as an institution of research is unfavourable; Padua to-day does not hold the highest rank as one of the producers of modern thought.

The history of Padua shows clearly the faults of a system that attempts to build on any other principles than those of free migration of students and the appointment of distinguished professors of creative minds.

This condition may be illustrated by an impression received in London. Although Padua has been specially famous for its medical teaching—Vesalius, Fallopius, Morgagni—and its distinguished student Harvey, it was impossible to find in any medical library in London an account of Padua, except Sir George Newman's interesting address to the students of St. Bartholomew's. This lack of interest corresponds to—or produces?—a reciprocal feeling on the part of the Italians. Most noticeable is the fact that most of the students can speak German, while very few know anything of English.

A most striking feature of the celebration was the large attendance of foreign delegates. The British delegation comprised Sir Archibald Garrod (Oxford) the chairman, Lord Dawson of Penn (Royal College of Physicians), Sir Humphrey Rolleston (Royal College of Surgeons), the Astronomer Royal, Sir Frank Dyson, (Royal Society), Prof. Conway (British Academy), Prof. Okey (Cambridge), Prof. Caton (Liverpool), Mr. D. G. Hogarth (London), Prof. H. H. Turner (London), Sir William Smith (London), Mr. Chaston Chapman (London), G. M. Trevelyan (London), Father Cortie (Stonyhurst), Dr. Seton (London), Dr. Scripture (Philological Society), Prof. Burnet (St. Andrews), Dr. Baird (Glasgow), Prof. Barger and Dr. H. R. F. Brown (Edinburgh), Sir George Smith, Prof.

MacWilliam and Prof. A. C. Baird (Aberdeen), Prof. Martin (Glasgow), Prof. Fitzgerald (Belfast), Prof. O'Rahilly and Prof. J. F. D'Alton (Cork), Sir Robert Woods and Mr. E. H. Alton (Dublin).

The Canadian delegation included Prof. Bieler (Montreal), Sir George Parkin (Fredericton), Mr. R. C. Archibald (Sackville), Dr. O. Klotz and Mr. E. Deville (Toronto), Dr. H. Ami (Ottawa). The university of Sydney sent Mr. C. MacLaurin. India was represented by Prof. Chatterji and Prof. Mallik of Calcutta.

At the solemn ceremony on May 15 the delegates were classified in groups. England, Scotland, Wales, Ireland, Canada, and Australia formed one group. France, Spain, and the South American States formed another group. Strange new States also appeared. One group comprised Esthonia, Latvia, Finland, Poland, etc. Germany had its independent place, while the countries of Asia were ably represented by Prof. Chatterji of Calcutta, who made a charming speech in English and Sanskrit.

Current Topics and Events.

FIVE fellows of the Royal Society are included in the list of honours conferred on the occasion of the King's birthday, namely, Dr. H. K. Anderson, master of Gonville and Caius College, Cambridge, Prof. W. M. Bayliss, professor of general physiology, University College, London, Prof. F. W. Keeble, Sherardian professor of botany, University of Oxford, Dr. T. R. Lyle, formerly professor of natural philosophy in the University of Melbourne, and Dr. E. J. Russell, director of the Rothamsted Experimental Station. Among other names we notice those of Sir B. G. A. Moynihan, professor of clinical surgery, University of Leeds, who has been made a baronet, Dr. J. Macpherson, professor of psychiatry, University of Sydney, and Dr. W. Thomson, lately registrar of the University of South Africa, who have received the honour of knighthood, and Mr. A. E. Kitson, director of Geological Survey, Gold Coast Colony, who has been made a Companion of the Order of St. Michael and St. George (C.M.G.).

REPORTS have appeared in the daily press of plagues of caterpillars defoliating oaks, particularly on the borders of Surrey and Hampshire. They have also been observed in the wooded country near St. Albans. Large numbers of the caterpillars, suspended by silken threads from the branches of the oaks, are a common feature of such infestations, and are often an annoyance to people walking along woodland roads. The insect primarily concerned is *Tortrix viridana*: the moth of this species is a small insect with pea-green fore-wings and smoky brownish hind-wings. During the end of this month it will appear in myriads throughout the countryside wherever the caterpillars have been abundant. Fortunately there is only one generation in the year and, once the moths appear, there will be no recurrence of the caterpillars during the same season, and the trees commence to shoot out fresh leaves. The effect of the defoliation naturally checks the growth of the trees to some extent for the time being, but is rarely more serious, and infestations of this kind are very common during hot dry weather.

WE notice with deep regret the announcement that Dr. W. H. R. Rivers, distinguished by his brilliant work in anthropology and psychology, died on June 4, at fifty-eight years of age.

IT is announced that Mr. C. T. Heycock, Goldsmiths' Reader in metallurgy at the University of Cambridge, has been appointed Prime Warden of the Goldsmiths' Company.

THE centenary of the death of René Just Haüy, "the father of crystallography," occurred on June 3. Haüy, who was of humble parentage, was born at Saint-Just-en-Chaussée, Oise, February 28, 1743. After great privations and extraordinary exertions, at the age of twenty-one he became a teacher in the College of Navarre in Paris. Here he began the study of botany. An accident, however, with a crystal of calcareous spar attracted him to the examination of minerals and led him to the discovery of the law of crystallisation. The happy issue of this was that he gained the favourable opinion of Daubenton and Laplace, and in 1783 was elected a member of the Academy of Sciences. Though as an ecclesiast he stood in some danger at the Revolution and was indeed committed to prison, his numerous friendships and the esteem in which he was held secured him from serious trouble. He afterwards became one of the first members of the National Institute, was secretary to the commission on weights and measures, lectured at the Ecole Normale, and held a chair at the Jardin des Plantes. Edward Stanley, the well-known Bishop of Norwich, when visiting the Jardin des Plantes in 1814, wrote: "Here as everywhere else the utmost liberality is shown to all, but to Englishmen particularly, your country is your passport. . . . Haüy, you know, is the first mineralogist in Europe and I never looked upon a more interesting being. When he entered the lecture room everyone rose out of respect, and well they might. He is 80 years of age apparently, with a most heavenly patriarchal countenance and silver hair . . . he looked like a man picked out of a crystal, and when he dies he ought to be reincarnated and placed in his own museum." Haüy's brother, Valentin, was the inventor of raised type for the blind, and in 1903 a monument to both of them was unveiled at Saint-Just. There is also a monument to the Abbé Haüy in Paris.

IN his presidential address at the anniversary meeting of the Royal Geographical Society on May 29, Sir F. Younghusband, the retiring president, dwelt briefly on the need for more intensive geographical examination of the homeland. The spadework of this form of exploration has of course been completed in topographical and geological surveys, faunas and floras and so forth, but the true geographical description is still far from complete. The

bare facts are not enough: it is necessary to be able to seize the essential characteristics of a country and, discarding unimportant details, to bring those essential characters together in a connected whole, in order to give a clear and definite impression that will readily implant itself upon the mind. This work, Sir F. Younghusband said, does not involve the problem of transport: it can be done far better on foot, and the homeland explorer does not even require the qualification of youth. "We [must] gather to us men with eyes to see, and hearts to feel, and heads to think, who will be fired with enthusiasm to explore round about their own homes and then come here and describe to us what they have seen."

THE March number of the *Tropical Agriculturist* contains an account of the work at the Royal Botanic Gardens, Peradeniya, Ceylon, the centenary of the establishment of which occurs this year. In 1810 Sir Joseph Banks drew up a plan for a botanic garden which was established two years later at Colombo. In 1822 the work was transferred to Peradeniya, near Kandy, the site of the late Kandian king's garden, under the superintendence of Alexander Moon. The first plan of the garden, which was 147 acres in extent, is now in the Library of the Royal Horticultural Society in London. Work of development, begun in earnest in 1844, with the appointment of George Gardner, received a temporary check on Gardner's death in 1849, but in the next thirty years, under the superintendence of G. H. K. Thwaites, the gardens attained considerable fame. Thwaites was succeeded in 1880 by Henry Trimen (1880–1896) who, continuing Thwaites' investigation of the flora of the island, brought out the well-known "Handbook of the Flora of Ceylon." J. C. Willis succeeded Trimen, but retired in 1911, when the gardens were placed under the newly constituted Department of Agriculture. Peradeniya has played an important part in the agricultural development of the colony in connection with the introduction and acclimatisation of plants of ornamental and economic value. The chief interest was coffee until the industry was ruined by the coffee-leaf disease, when it was replaced by cinchona and subsequently tea. The rubber industry of the East owes much to the work in Ceylon, where seedlings were transferred from Kew in 1876; in 1906 the first of the World's Rubber Exhibitions was held in the Peradeniya Gardens. In 1887 a small botanical laboratory was fitted up in the gardens, and many British and Continental botanists have taken advantage of the facilities thus afforded for the study of botany in the tropics. In 1900 this was replaced by a larger well-equipped building.

THE third annual report of the Governors of the Imperial Mineral Resources Bureau, which has recently been issued, contains much interesting information. It is gratifying to see that at last a serious attempt is being made to adopt a unified system of mineral statistics applicable to the whole of the British Empire. This reform is long overdue, and it is to be sincerely hoped that the present effort will meet with success. The greater part of the report is devoted to a general review of the mineral industry of the British Empire and foreign countries for the year 1921, and the importance to the industry of such a comprehensive review at so relatively early a date can scarcely be overestimated. Even if the figures given are only approximately correct, they will serve as a trustworthy guide to the general trend of the industry. Unfortunately the picture is a very gloomy one, being a practically uniform chronicle of world-wide depression; almost the only exception is to be found in the coal production of Germany, which shows an appreciable improvement on that for 1920, and in the words of the report, "Considering the loss of the coal production of the Saar, the approach of Germany's fuel production in 1921 to the pre-war figures is significant."

A LECTURE on the mechanical construction of the microscope from a historical point of view, given by Prof. Alan Pollard before the Optical Society on April 27, dealt with the evolution of the instrument from the earliest times until about the middle of the nineteenth century. Prof. Pollard divided his subject into two main periods—the non-achromatic, in which the early history of the single lens or simple microscope was dealt with, and the achromatic. The mechanical details of outstanding historical compound instruments of these two periods which marked the progress of mechanical construction to the modern compound microscope, were described. Many famous instruments of the first period, such as John Marshall's "New Invented Double Microscope" of 1693, Culpeper's "Double Reflecting Microscope" of 1735, Cuff's "Double Constructed Microscope" of 1744, B. Martin's simple and compound instruments of 1765, Bleuler's "Universal" of 1788, Jones' "Most Improved" of 1798, by Dollond, Gould's "Pocket Microscope" of 1828, by Cary, as well as Lister's famous compound microscope, by James Smith in 1826, which marked the opening of the second period in this country, were set up with histological specimens so that their mechanical and optical performances could be compared. In addition, early catoptric instruments were shown, including Amici's reflecting microscope, made for Dr. Wollaston in 1830. The development in particular of the modern English limb from the Lister and Jackson designs, and the so-called continental limb from the early forms of Oberheuser and Nachet, was traced and described.

THE gold medal of the Linnean Society of London, which is given in alternative years to a botanist and a zoologist, was this year awarded to Prof. E. B. Poulton at the anniversary meeting on May 24. In making the presentation, the president, Dr. A. Smith Woodward, referred to Prof. Poulton's long labours in entomology, and his keepership of the Hope Collection at Oxford, transformed by him into a great museum, illustrative of variation, mimicry, and evolution. Prof. Poulton, in replying, mentioned the fact that half a century had elapsed since his matriculation at Oxford. At the same meeting of the Society the following officers were elected: *President:* Dr. A. Smith Woodward; *Treasurer:* Mr. Horace W.

Monckton; *Secretaries:* Dr. B. Daydon Jackson, Prof. E. S. Goodrich, and Dr. A. B. Rendle; *Members of Council:* Prof. Margaret Benson, Dr. G. P. Bidder, Mr. E. T. Browne, Dr. W. T. Calman, Prof. F. E. Fritch, Prof. E. S. Goodrich, Dame Helen Gwynne-Vaughan, Sir Sidney F. Harmer, Dr. Arthur W. Hill, Dr. B. Daydon Jackson, Mr. Gerald W. E. Loder, Mr. Horace W. Monckton, Mr. Frank A. Potts, Capt. John Ramsbottom, Dr. A. B. Rendle, Baron Rothschild, Dr. E. J. Salisbury, Mr. Charles Edward Salmon, Mr. Thomas Archibald Sprague, and Dr. A. Smith Woodward. Among the Vice-Presidents nominated for the present session appears the name of Dame Helen Gwynne-Vaughan, the first woman to attain that dignity, although it is nearly eighteen years since women were eligible for the fellowship, and for the last fifteen years they have been elected to the Council.

THE Council of the Institution of Electrical Engineers has made the following awards for papers accepted during the session 1921–22: the Institution Premium to Mr. J. G. Hill, the Ayrton Premium to Mr. L. H. A. Carr, the Duddell Premium to Mr. T. L. Eckersley, the Fahie Premium to Mr. E. S. Byng, the John Hopkinson Premium to Mr. F. P. Whitaker, the Kelvin Premium to Mr. R. Torikai, the Paris Premium to Mr. J. A. Kuyser, extra premiums to Mr. J. Anderson, Mr. F. J. Teago, and Mr. W. Wilson, wireless premiums to Mr. E. B. Moullin and Mr. L. B. Turner, and Mr. C. S. Franklin; and the Willans Premium, which is awarded triennially alternately by the Institution and the Institution of Mechanical Engineers, to Mr. K. Baumann.

THE British Non-Ferrous Metals Research Association, 71 Temple Row, Birmingham, has carried out an extensive research on the influence of gases on high-grade brass. A further investigation is now being started by the Association at the Research Department, Woolwich, in which the support of the Engineering Co-ordinating Board of the Department of Scientific and Industrial Research has been secured. The prime object of the present work is to study the conditions necessary for securing both surface and internal soundness of strip brass ingots such as are required for cold rolled sheet metal. The investigation should also throw light on other types of casting in non-ferrous alloys and should be of interest to a wide circle of manufacturers in the metal and engineering trades. Dr. Harold Moore and Mr. B. Genders will have charge of the research, which will be conducted partly in the works of members of the Association and partly in the Woolwich laboratories.

BEFORE the war the United States did not undertake the manufacture of optical glass; thus the disc for the 100-inch at Mt. Wilson was made at St. Gobain in France. The exigencies of war, however, made home-manufacture necessary, much help being given by the geophysical laboratory at Washington. The work was at first limited to the small lenses needed for military purposes, but after the Armistice it was greatly extended, and electric furnaces were constructed for annealing the glass, the rate of cooling being carefully controlled. In an article in *Popular Astronomy* of May, D. E. Sharp states that a 40-inch disc for a reflector for the Steward Observatory, University of Arizona, has now been completed by the Spencer Lens Co., Hamburg, N.Y. The glass employed has a low coefficient of expansion, and it is hoped that changes of figure due to change of temperature will thus be minimised.

A BRONZE medal to be designated the Faraday Medal of the Institution of Electrical Engineers will commemorate the fiftieth anniversary of the first Ordinary Meeting of the Society of Telegraph Engineers (now the Institution of Electrical Engineers). The award may be made by the Council not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the Institution.

INVITATIONS have been issued by the Lawes Agricultural Trust Committee (Chairman, Lord Bledisloe) to inspect the experimental fields and laboratories of the Rothamsted Experimental Station, Harpenden, on Wednesday, June 14, when the Minister of Agriculture (The Right Hon. Sir Arthur Griffith-Boscawen) and the Parliamentary Secretary (the Earl of Ancaster) will be present.

THE seventy-seventh general meeting of the Institution of Mining Engineers will be held on June 20–22 at Sheffield. A preliminary programme has been issued, which provides for papers and discussions on stainless steels, rock temperatures in coal-measures, coal-mining methods and apparatus, and the absorption of carbon monoxide by the blood. A number of visits to works and collieries in the neighbourhood have also been arranged.

A PUBLIC meeting of the National Union of Scientific Workers will be held in the Botanical Theatre, University College, Gower Street, London, on Thursday, June 15, at 5.30, when an address will be given by Mr. F. W. Sanderson, Headmaster of Oundle, on "The Duty and Service of Science in the New Era." The chair will be taken by Mr. H. G. Wells. Admission will be free.

IT is announced in the *Chemiker Zeitung* of May 18 that Prof. Duparc of Geneva has, at the invitation of the Soviet Government, undertaken the organisation of the platinum industry of Russia.

THE movement for "birth control" has now assumed considerable proportions, and the Malthusian League, which numbers many persons of eminence in medicine, science, and literature among its vice-presidents, issues monthly the *New Generation*, a publication devoted to this subject and to problems of population. The "Mothers' Clinic," for information and advice on the subject, has been established and is open daily, and issues monthly the *Birth Control News*, which "intends to present to those who desire to see them shorn of the ephemeral, the real problems facing national and international statesmanship to-day."

Research Items.

The Sacred Herakleopolite Nome Tree.—In *Ancient Egypt* (Part 1, 1922), Dr. F. F. Bruijning concludes his interesting paper on the sacred tree of the Egyptian Herakleopolite Nome. From numerous representations of this famous tree on the monuments, he reaches the conclusion that it may be identified with the wine-palm, *Raphia monbuttorum*, which has since then retreated southward, keeping its place longest where the special conditions for its growth, a warm, damp air and soil, as in the oases, were favourable. Most of the so-called "artichokes" represented among the funeral offerings undoubtedly represent the palm-cabbage, and older interpretations, such as the theory that they represent pine-cones, must be set aside. A clear distinction must be drawn between palm-wine, obtained from the sap of various species, drawn by incisions in the spadix or head, or by cutting off the spadix, and date-wine in which, as with other fruits, the ripe fruit is mashed, pressed, or boiled, and then fermented.

The Osage Tribe of American Indians.—The Bureau of American Ethnology in its thirty-sixth Annual Report, 1914–15, publishes a fine, illustrated monograph on the Osage tribe by Mr. F. la Flesche. Marquette first visited them in 1673, and thus a trading relationship was established with Spanish and French merchants. In 1806 began the crisis in their history, by which they gradually relinquished their territory to the United States, and in 1825 they gave up their ancient home and removed to a reservation in Kansas. Their present quarters are in Osage County, Oklahoma, where they removed in 1872. They are rapidly, as a tribe, approaching extinction, not by death but by absorption by the whites, and only a small minority are now of pure blood. They belong to the great Siouan linguistic family, their nearest kindred tribes being the Omaha, Ponca, Quapaw, and Kaw. The volume contains, both in the tribal dialect and an English translation, a full account of their tribal rites—the Rite of the Chiefs, which records their traditions in a cryptic form, and the Hearing of the Sayings of the Ancient Men. They were accustomed to appeal daily to Wakonda for a long and healthful life. "Therefore at dawn, when they saw the reddened sky signalling the approach of the sun, men, women, and children stood in the doors of their houses and uttered their cry for divine help: as the sun reached mid-heaven they repeated their prayer: and their supplications again arose as the sun touched the western horizon."

Bacteria associated with Rice and other Cereals.—Starch is prepared from tubers and cereals, and of these rice probably holds the first place as a source of starch. The raw material is washed, steeped, and ground with water, so that the starch separates from other constituents of the grain, and the milky suspension is allowed to stand in tanks in which the starch is deposited. Fermentation due to bacteria is liable to occur, particularly during steeping and settlement, and may cause serious loss. The chief source of bacterial infection is the grain itself. It is found that "polished" rice carries more bacteria than "unpolished" (*i.e.* unhusked) rice, due apparently to the removal with the protective epidermis of the grain of an alkaloidal substance which has antiseptic properties. When not required for seed the grain may be sterilised by means of sulphur dioxide. Ordinary "paddy," rice grain as it comes from the fields, carries sporing bacilli which are capable of fermenting the starch with the production of acetone and butyl alcohol—as much as 8-9 per cent. of acetone on the weight of rice taken being obtained (G. J. Fowler and Dhiresh Zobhan Sen, *Journ. Indian Inst. of Science*, Vol. 4, Pt. VIII., p. 119).

Migration Instinct in Birds.—Mrs. C. D. Langworthy of Claygate, Surrey, raises the question of the migration of young cuckoos as an example of "inherited memory." The adult cuckoos, being free from family cares, emigrate very early and have all left the country some weeks before the young ones, which they have never seen, are ready for the journey. The young must thus find their way unaided. There is no evidence that the foster-parents' example plays any part; indeed the latter are frequently birds of sedentary habit. A similar phenomenon also takes place in the case of many other migrants, such as the starling, for example, but with the order reversed; the young migrate separately when only a few weeks old, the adults following later after completing their autumn moult. These cases are scarcely easier to explain than that of the young cuckoos, for it is difficult to imagine anything equivalent to theoretical instruction beforehand. Migration is a very regular phenomenon, occurring year after year according to the same plan; much of it, too, takes place before the need has become really apparent, and thus it cannot be explained simply as the result of immediate stimuli and of the pressure of external circumstances. It is therefore difficult to escape the conclusion, not only that the migratory habit is an inherited instinct, but that some foreknowledge of the journey to be performed is in some way inborn.

New Dinosaur from New Mexico.—Mr. C. W. Gilmore describes "A new Sauropod Dinosaur [*Alamosaurus sanjuanensis*, n. gen. et n. sp.] from the Ojo Alamo formation of New Mexico" ("Smithsonian Miscellaneous Collections," vol. lxxii., No. 14). The remains so far recovered consist of a left scapula and a right ischium, both in a good state of preservation. The great importance of these particular bones lies in the fact that the remains of sauropodous dinosaurs have not previously been known to occur above the Lower Cretaceous in North America, so that the extension of their geological range into the Upper Cretaceous is of the greatest palæontological and geological interest. Much doubt attaches, in Mr. Gilmore's opinion, to the proper identification, or exact geological position, of the reported finds in other parts of the world of sauropod remains of Cenomanian age or later, although such dinosaurs doubtless continued to exist until after the Cenomanian and even into the Danian.

New Surveys in Arabia.—The *Geographical Journal* for May contains a new map of northern Arabia prepared by the Geographical Section of the General Staff. The map incorporates the work of the late Capt. W. H. I. Shakespear, especially his great journey across Arabia in 1914 from Koweit on the Persian Gulf to the Egyptian outpost of Kuntilla in Sinai. These observations were utilised during the war in the construction of the 1/M map of Arabia, from which the present map is reduced to the scale of 1/1·5 M. Mr. D. Carruthers, in an article accompanying the map, points out that Capt. Shakespear's trans-Arabian journey covered about 1200 miles of unknown country and that for the whole distance, 1810 miles, he kept up a continuous route traverse, checked at intervals by observations for latitude.

Hypsometric readings for altitude were also taken. The new work included the first complete traverse of the Wadi er Rumma in its lower course, el Batin; the region southward to Zilfi and thence to Riyadh; much new detail between Riyadh and Buraida; and a completely new route from Buraida to Jauf and between Jauf and the Wadi Araba on the frontier of southern Palestine.

DEATH VALLEY.—An article is given in the U.S. *Monthly Weather Review* of January last by Mr. Andrew H. Palmer of the U.S. Weather Bureau on the weather at the Bureau's substation at Greenland Ranch in Death Valley, California. The valley extends from north to south for a distance of about 100 miles, and lies between high mountain ranges. The width varies from two to eight miles, and it is the deepest depression in the United States. The instrument shelter is 178 feet below sea level, and the maximum and minimum thermometers with the thermometer screen, as well as the 8-inch rain gauge, are lent by the Weather Bureau. Unbroken weather records are now available for more than ten years. Nearly every summer the highest temperatures observed in the United States occur in Death Valley. The extreme maximum temperatures recorded during the last eleven years, to 1921, range from 134° F. in 1913 to 120° in 1912; the extreme of 134° F. observed on July 10, 1913, is said to be the highest natural air temperature ever recorded on the earth's surface by means of a tested standard thermometer exposed in a standard louvered screen. Temperatures of 100° or higher occur almost daily during June, July, and August; in July 1917 the mean temperature was 107°·2. Not infrequently six consecutive months have passed without measurable rain. In 1917 the total rainfall was less than half an inch, and the annual average precipitation is less than two inches. There is said to be some sunshine during practically every day in the year. Four crops of alfalfa are gathered each year.

GEOLOGICAL RESEARCH AND EDUCATION IN CONNECTICUT.—The Connecticut State Geological and Natural History Survey has collected its bulletins issued between 1915 and 1920 as volume vi. of its publications, which are distributed gratuitously "to public libraries, colleges, and scientific institutions, and to scientific men, teachers, and others who require particular bulletins for their work, especially to those who are citizens of Connecticut." The present thick but easily opened volume contains over 1100 pages, with abundant plates, maps, and other illustrations. Geologists will welcome Prof. R. S. Lull's treatise on "Triassic Life of the Connecticut Valley," as a record of life and conditions on the land at the opening of Mesozoic times. We are present, as it were, at the rise of the dinosaurs, and the original restorations serve admirably to impress the characters of these dominant forms on the minds of every teacher in the schools. Podokesaurus, recently discovered and described by Miss M. Talbot, is fully discussed and illustrated, for comparison with its Upper Jurassic ally, Compsognathus. A complete review is given of the footprints that abound in the shales and sandstones, especially in the upper beds of the system; some may represent amphibia, but the associated bones show that many must be ascribed to dinosaurs. Bulletin 26, by Prof. V. W. Kunkel, describes the existing amphipod and isopod Crustacea of the State, and Dr. W. C. Britton gives a list of the insects, occupying 400 pages.

THE FLOTATION OF CONTINENTS.—Prof. Wegener's views on continental movement were stated in a recent review (NATURE, February 16, p. 202) of the second edition of his work on "Die Entstehung der Kontinente und Ozeane." His daring suggestions were formulated in 1912, and we cannot quite dismiss them as Prof. L. Kober does, by saying "im Bau der Erde hat die Theorie der grossen Kontinentalverschiebungen keine Stütze." However much we may doubt the horizontal movement of masses of "sal" across uncrumpled "sima" areas, the proposition that has arisen in the mind of a geographer can be met only by argument on the part of the geologist. Prof. Wegener has contributed to *Discovery* (vol. iii. p. 114, May 1922) a lucid summary of his conceptions, accompanied by maps, showing, among other wonders, the transference of the Deccan to the antarctic region in Carboniferous times. A polar ice-cap, spreading across the conference of continents here cunningly arranged, would not explain the movement of an ice-sheet from north to south in southern Africa. Mr. A. L. du Toit, however, in two notable papers dealing with former land-connections and the glaciation of South Africa (*S. African Journ. Sci.*, vol. xviii., Dec. 1921, and Trans. Geol. Soc. S. Africa, vol. xxiv. p. 188, 1921) welcomes the new hypothesis. His map of Gondwanaland as promoted by flotation, with its arrows showing the direction of ice-movements, seems to require a snow-dome near the south of Madagascar, and a separate glaciation of Australia by the polar cap. We should like to study Prof. Wegener's explanation of the arid climates of the Trias, and of the cold conditions prevalent over the whole earth in the latest glacial epoch. For him, New Zealand (see NATURE, vol. 109, p. 657) has been left behind by the westward drifting of Australia, and his "Old Quaternary" map does not explain its glaciation on geographic grounds. The Carboniferous map shows a general submergence of Eurasia, so that his seeming repudiation of vertical movements in accounting for changes on the earth's surface may be something like the waving of a red flag at the head of an orderly industrial procession. We shall hope for a thorough discussion of his proposals in the light of what is known as to marine transgressions across the continents.

EFFECT OF LIGHT ON MUSEUM SPECIMENS.—The *Museums Journal* for April contains a detailed account by the Director of the Natural History Museum of the careful experiments that he has conducted there for many years, with the help of the late W. G. Ridewood, on the fading of colour in museum specimens. Direct sunlight is, says Sir Sidney Harmer, far more injurious to colours than any other method of illumination, and diffused daylight appears to produce more fading than any form of electric light used. This statement applies to oil-colours as well as to water-colours and the colours of various animal coverings, and suggests caution to those who, on the advice of Sir M. H. Spielmann, would put their oil-paintings in a blaze of sunlight. The various glasses designed by Crookes and others to cut off the more deleterious rays were not found sufficiently satisfactory to warrant the expense of their installation. The practical conclusion of the whole matter is that direct sunlight should be avoided at all costs, and that even diffused daylight should be shut out at all hours when exhibition galleries are closed to the public. At other times the light, if at all bright, should be moderated by yellow blinds. A gallery lighted entirely by electric light, preferably in the form of half-watt lamps, would have great advantages. The paper is one that should be studied by all directors of museums, including art galleries.

The International Union of Geodesy and Geophysics.

THE first meeting of the General Assembly of this Union, which was held at Rome at the beginning of May, was attended by delegates from the fourteen countries which at present form the Union, and also by a number of representatives from several other countries which, though belonging to the International Research Council, have not yet joined the Union.

The Union, which was constituted at Brussels in 1919, has for its object the promotion of the study of geodetic and geophysical problems and of international co-operation in research. It covers not only the ground with which the former International Associations of Geodesy and Seismology dealt, but its sections provide for similar activities in meteorology, terrestrial magnetism, physical oceanography, vulcanology, and scientific hydrology.

The meetings of the Union and its constituent sections were held in the rooms of the Reale Accademia dei Lincei on May 3–10, and were preceded by an official reception of the delegates and members of the Astronomical and of the Geodetic and Geophysical Unions by the Minister of Public Instruction at the Capitol, at which His Majesty the King of Italy was present.

As the meeting in Brussels in 1919 was held for the special purpose of constituting the International Research Council and the Unions which are related to it, no scientific discussions took place there; since then the organisation of the Union and its sections has entailed a considerable amount of work. At Rome, therefore, each section had to prepare its plans for international work, and in the case of geodesy and seismology, to review the progress which had been made since the last international meeting. In all sections good progress was made, and plans were adopted for the work which will be put in hand in the period which will elapse before the next meeting of the Union in 1924.

In geodesy the programme was a heavy one, for ten years have elapsed since the last meeting of the International Geodetic Association at Hamburg in 1912. Very interesting summaries of the work which it has been possible to carry out during this period were presented by the delegates of the various countries, and these will be published in the report of the section of geodesy. It had been suggested at Brussels that the study of variation of latitude should be confided to the Union of Astronomy instead of to that of Geodesy. The question was fully discussed at Rome by a committee representing the two Unions, and it was decided that the subject should remain with the Section of Geodesy, a joint committee of geodesists and astronomers, with Prof. Kimura as chairman, being appointed to direct the work.

To carry out the decisions of the Section, and to deal with any matters which might arise, an executive committee was appointed, as well as a General Committee, on which each country adhering to the Section will be represented. The General Committee will be consulted on matters which go beyond the powers of the executive committee in the interval between two meetings.

For each principal branch of technical work a reporter was appointed who will prepare a statement on the progress made in it for the periodical conferences, and will also facilitate co-ordination between workers in different countries. Mr. W. Bowie of the U.S. Coast and Geodetic Survey continues as president, with Lieut.-Colonel G. Perrier of the French Geodetic Service as secretary.

As the International Seismology Association was still in being at the time of the Conference at Brussels, no change could then be made, and the Section of Seismology was only constituted at Rome, when Prof. H. H. Turner, of Oxford, was elected president, with Prof. Rothé of Strasbourg as secretary. The subjects for discussion included the study of microseisms, the depth focus of earthquakes, and proposals for studying explosion phenomena and wave propagation. Much work was done in organising the Section, and in planning work to be undertaken before its next meeting. The work now being done at Oxford and at Strasbourg is to be carried on, and to this the Section will give such assistance as it can.

Meteorology is represented in the Union by a Section which is a new organisation in so far as it does not replace a pre-war institution of a corresponding character. Its relations to the International Meteorological Committee, which has been in existence for many years, came up for discussion; this committee consists of a certain number of Directors of meteorological services, and at its periodical conferences, such as that which met at Paris in 1919, many questions are discussed which arise from the relations existing between the meteorological services of different countries. It was agreed that, in addition to questions of this character, there were many investigations for which international co-operation was essential, which directors of meteorological services might find it difficult to include in their work. Such investigations might with advantage be initiated by the Section, and at Rome plans were discussed for work of this character. The composition of the atmosphere at high altitudes, and the physical conditions prevailing in the stratosphere, were specially considered as being subjects in which an increase of our knowledge is highly desirable, and plans for work upon them were adopted. It is clear that the two organisations would in no way overlap, but that the work of each would usefully supplement that of the other. Sir Napier Shaw was elected president of the Section, with Prof. Eredia of the Italian Meteorological Service as secretary.

The Section of Terrestrial Magnetism and Electricity was fully occupied with a long programme dealing largely with methods of observation and with the reduction of results; no particular method of scale-value determination was agreed upon in view of the diverse types of instruments in use. The selection of one observatory in each country which should take part in the international comparison of instruments was advocated, and a committee was appointed to formulate a scheme for such intercomparisons. Other committees were formed to deal with polar-light observations, with earth currents, and observational work in atmospheric electricity. Dr. C. Chree was elected president, with Dr. L. A. Bauer as secretary.

The Section of Physical Oceanography had held one meeting in Paris in January 1920, at which committees were nominated to facilitate co-operation in oceanographical work in the Atlantic, in the Pacific, and in the Mediterranean. At Rome these were confirmed, and the recommendations of the Tidal Committee for improving the collection of tidal information and data, and for attaining uniformity in their reduction, were adopted. A proposal to provide, by means of a committee or a section, for the co-ordination of biological work in oceanography with the physical work of the Section, was adjourned until the next conference in order that opinions from various countries might be obtained. H.S.H. the Prince of Monaco continues as president, with

Prof. G. Magrini of Venice as secretary. The publication of a periodical which would deal specially with the bibliography of the subject was also approved.

In the Section of Vulcanology, which was formally constituted at the Conference, M. Lacroix was elected president, with Prof. Malladra and Prof. G. Platania as secretaries. Proposals for the classification of volcanic phenomena, and for the recording of volcanic outbursts, were adopted, as also were those for the investigation of the thermal gradient in certain areas.

In more than one quarter the proposal had been made that an additional section should be formed to deal with the scientific problems which arise in various hydrological investigations, such as river-gauging, lake phenomena including seiches, run-off and evaporation, transport of material in suspension and in solution, glacier movement, etc. A committee examined the matter carefully and reported in favour of forming a Section of Scientific Hydrology. The recommendation was adopted by the General Assembly, which nominated Mr. B. H. Wade of the Physical Department, Cairo, as president, and Prof. G. Magrini as secretary.

The General Assembly of the Union re-elected M. Ch. Lallemand to be president, Colonel H. Lyons remaining secretary-general. It was resolved that countries belonging to the International Research Council which had formerly been members of the International Geodetic Association might join the Union and the Section of Geodesy, without subscribing to the other sections, if they so desired. It was further resolved that the next meeting of the Union should be held in 1924, and an invitation from the Spanish Government to hold the next Conference of the Union at Madrid was accepted. It is understood that the probable date will be the latter part of September.

Arrangements were made for members to visit, after the Conference, the Central Institute for Marine Biology at Messina, and the Marine Research ship *Marsigli*. For those interested in vulcanology visits to Stromboli, Catania, Etna, and Naples were arranged, while at Florence the Observatory and the various scientific institutes and museums were open to the members, to whom the municipality gave a reception at the Palazzo Vecchio.

The proceedings in each Section will be published in due course by the Executive Committee of the Section.

H. G. L.

Annual Conference of Universities.

ALL the Universities of Great Britain and Ireland were represented at the Conference which met at University College, London, on May 13. Each University had been asked to send three representatives in addition to its executive Head, and each University College to send its Principal and one other representative. Of the Vice-Chancellors or Principals three only were unable to attend. Sir Donald MacAlister (Glasgow), chairman of the Standing Committee of Vice-Chancellors, presided. Mr. Fisher, President of the Board of Education, was present and took part in the discussions.

The subject of the urgent need for the provision of enlarged opportunities for advanced study and research was introduced by Principal Irvine (St. Andrews), who pleaded that the Universities should not leave original research to the solitary worker, but should place facilities for research in the way of every one naturally equipped with the spirit of inquiry. It is impossible to summarise Principal Irvine's address, but the main contention was that training in research should be in the hands of mature investigators who should be relieved of all routine and administrative work. Principal Sibly (Swansea) said that the importance of the applications of science had become so clear to the public during the war that technological studies were now greatly favoured and the opportunities of prosecuting pure science were actually narrower than they were ten years ago. Sir Richard Lodge (Edinburgh) sounded a warning that training may be overdone. Many a research worker, left to himself, has learned more from his blunders than from his supervisor's advice. He emphasised the value of the Institute of Historical Research, which should, he thought, have a semi-federal character and be regarded, not as the possession of a single University, but in some degree, as common to all, since all historians must come to London to consult the documents which they need for the purposes of research. In this he was supported by Principal Grant Robertson (Birmingham).

The need for an increase in residential accommodation for students was urged by Sir Michael Sadler (Leeds), who stated that the desire for college life had recently been greatly strengthened in the newer Universities. In part it has been met. The increase in accommodation during the past year amounted to no less than 17 per cent. But very much more is needed. Women students equally with men recognise that, unless they share in the corporate social life of a Hall of Residence, they do not reap the full benefit of a University career. A very valuable discussion of the details of organisation and management followed, in which various speakers, drawing upon their own administrative experience, stated, amongst other things, that they had found that from 65 to 75 students is the economical unit (Principal Childs would place the number somewhat higher), that the Halls (the term "Hostel" was generally disapproved) should be independent of the Universities, that younger members of the staff should be encouraged to live in the Halls, that discipline and even management must be largely in the hands of the students, and that students must have some degree of privacy. It was agreed that no teaching should be given in the Halls. The most desirable situation for Halls in industrial towns was also discussed. For health and recreation they should be grouped around the playing-fields. This means that the residential quarters will be at a distance from the University buildings. Danger will arise, in consequence, of a division of the University into two groups of students with different centres of patriotism. This can be met by the provision in the immediate neighbourhood of the University of commodious "Union" buildings, and by encouraging the students who live at home or in lodgings to found a "Hall" with a warden and elected officers.

Dr. L. R. Farnell (Oxford), in introducing the subject of specialisation in certain subjects of study by certain Universities, argued that the time has passed when every University can attempt to foster all the shoots which are constantly being thrust forth by the tree of knowledge. Some flourish only where local conditions are favourable, others are so esoteric that a few centres will satisfy the needs of all their votaries. Mr. Fisher endorsed the views of the Vice-Chancellor of Oxford. When the Govern-

ment gave their support to the Universities Bureau they did so with the view of inducing the Universities to take counsel together, to encourage co-operation, and to enable overlapping to be avoided, without that external interference which they all deprecated. The development of applied science has reached dimensions which make it imperative, if the nation as a whole is to advance, that much more consideration than has hitherto been thought necessary should be given to the distribution of studies. The more conference there is between those responsible for University policy in England and Scotland the better it will be, especially if we are to look forward to a certain number of lean years. He suggested that the Vice-Chancellors' Committee be asked to consider (1) what new specialist departments, requiring for their development new endowments, may be appropriate to particular Universities; (2) whether existing trust funds in particular Universities could be applied to better uses within those Universities; and (3) whether the statutes of the different Universities could be so altered as to facilitate migration, in order that students may obtain specialist teaching. The chairman promised to report Mr. Fisher's proposals for inquiry to the next meeting of the Vice-Chancellors' Committee.

The subject of the Organisation of Adult Education as an integral part of the work of the Universities was introduced by Sir Henry A. Miers (Manchester), chairman of the Conjoint Committee of the Universities and the Workers' Educational Association, who pointed out the desirability of bringing into co-operation many bodies in addition to the one in which he is especially interested. He and subsequent speakers emphasised the importance of restricting the expression "Higher Education" to its legitimate sense as such a standard of education as only Universities can provide. There is a real danger of the Universities, moved by sympathy for those who have done great things in the way of making good early deficiencies, accepting as "higher," education which is not of a University type. There is also danger of trade-unions imagining that they can employ imperfectly trained persons as instructors. Mr. R. Peers, head of the Department of Extra-mural Teaching, gave a very interesting account of the organisation of Adult Education undertaken by the University College of Nottingham.

The Centenary of the Royal Astronomical Society.

THE actual date of the centenary of this Society was February 1920. Prof. A. Fowler, who was then president, delivered an appropriate address on that occasion, recapitulating the circumstances of the origin and early history of the Society. It was felt, however, that the conditions of foreign travel were still too difficult to render the occasion suitable for a full celebration of the event. Early in the present year it was thought that it would be well to take advantage of the presence of a large number of astronomers in Rome, at the meeting of the International Astronomical Union, many of whom, it was hoped, would be able to visit London on their way home. The end of May was therefore chosen as the date for the celebration, which was attended by a considerable number of associates.

The celebration opened with a conversazione on May 29, for which the Royal Society kindly lent its rooms; more than 300 guests were present; the exhibits included a collection of Newton relics, a number of ancient astronomical and mathematical books, calculating machines, and a model illustrating the probability curve. Five short lectures were delivered in the meeting room, on Sunspots, Planets, Comets, Instruments, and an anecdotal lecture on some former Fellows.

The morning of May 30 was devoted to addresses on the history of the Society. Prof. Eddington, the president, read the loyal message which had been sent to the King, as Patron of the Society, also his gracious reply, of which the following is an extract:

"You can rest assured that the King watches with interest and admiration the patient, diligent, and unobtrusive manner in which the Fellows of the Society conduct their unremitting research, in the hope that they may, by piercing the hidden mysteries of the skies, add step by step to the store of scientific knowledge, and thus contribute so much that is essential to the progress of mankind on land and sea."

He then read messages from many of the absent associates, which spoke of the great work that the Society had done for astronomy during the century of its existence, and expressed confident hope that its future would be equally fruitful. Similar messages of congratulation were received from many scientific societies.

The inaugural address by the president was a general survey of the progress of astronomy during the century; he suggested the following six events as marking definite steps of progress: 1839, the first stellar parallaxes were measured by Bessel and Henderson; 1846, Neptune was discovered as a result of the solution of the problem of inverse perturbations by Adams and Le Verier; 1854–58, the commencement of astronomical spectroscopy by Huggins and Lockyer; 1882–87, the beginning of stellar photography; 1904, Kapteyn's discovery of the two star-streams, which led to the beginning of stellar dynamics; 1920, the first direct measure of a star's diameter, by the Mt. Wilson interferometer. On the whole the twentieth century has been marked by the shift of the main interest from the solar to the stellar system. The former, however, is not entirely neglected; Prof. Eddington instanced planetary photography, the discovery of new faint satellites, and the Trojan group of asteroids, Einstein's explanation of the motion of Mercury's perihelion, the work of Taylor and Jeffreys on tidal friction in the Irish Sea, and Jeans's work on the cosmogony of the solar system.

Dr. Dreyer then delivered an address on the history of the Society, referring to the low ebb that astronomy and mathematics had reached in England before its foundation. One reason given was the continuance of the clumsy fluctional notation, which had already been superseded on the continent. One method attempted for encouraging research did not meet with great success; this was the offer of prizes for the solution of certain problems; it was noted that the prize offered for the mathematical treatment of the Saturnian satellite system met with a reply 80 years later, when Dr. Hermann Struve was awarded the Gold Medal for his work on Saturn's system. Reform of the Nautical Almanac was another work in which the Society interested itself. It awarded the Gold Medal in 1830 to Encke for his improved Berliner Jahrbuch; in 1834 our own Almanac followed suit. In 1835 the Society was given rooms in Somerset House, where it remained till it occupied its present abode in 1874. Allusion was made to the absorption of the Spitalfields Mathematical Society in 1845; it enabled them to claim

that in a sense they were keeping their second centenary, since that Society went back to 1717. Most of their old mathematical books were acquired from that Society. Allusion was made to the invaluable services of two assistant secretaries, Mr. Williams, known for his studies of Chinese comet records, and Mr. W. H. Wesley, who had now held that office for 47 years; much to their regret, illness prevented him from taking part in the centenary celebration. Allusion was made to the Society being consulted on the question of the remeasurement of the fundamental arcs in the British survey, and to the granting of the new charter in 1915, permitting the election of lady Fellows.

Prof. Turner followed with a biographical address, illustrated by portrait slides; he began with Queen Victoria, who had been their Royal Patron during two-thirds of their existence. He noted that former kings of Denmark and Siam had been honorary members, a distinction also awarded to Caroline Herschel, and several other famous lady astronomers, the latest being Miss Annie Cannon. The portraits included Sir W. and Sir J. Herschel, Francis Baily, Daniel Moore, Stephen Groombridge, Mr. Colebrook, Richard Taylor (first editor and printer of the Monthly Notices, and founder of the firm of Taylor and Francis).

The afternoon meeting was opened by the reading of the minutes of the preparatory meeting held at Freemason's Tavern, Gt. Queen St., Lincoln's Inn Fields, on January 8, 1820, at which Mr. Daniel Moore was chairman, the fourteen persons present all signing the declaration that they would help to forward the formation of the proposed Society.

Six of the Associates present were then invited to speak on their recent work. Dr. Seares spoke on the systematic differences of colours of giant and dwarf stars of the same type, the dwarfs being redder; he also discussed absolute magnitude as a function of galactic latitude. Prof. Strömgren spoke on solutions of the three-body problem by mechanical quadratures. Prof. H. Shapley spoke on his recent work of finding absolute magnitudes from objective prism spectra; also on the local cluster round the sun, stated to be 2000 light-years in diameter, and on the recent discovery of faint Cepheid variables in the Magellanic Cloud.

Dr. Hertzsprung spoke on the Cepheid variable RR Lyræ, showing that it has several superposed periodicities.

Dr. Aitken dealt with double stars, stating that his special aim was to form an exhaustive catalogue of all doubles down to the ninth magnitude within certain limits of distance. He stated that 15 per cent. of his discoveries already show orbital motion.

Dr. St. John spoke on the absence of the lines of oxygen and water vapour from the spectrum of Venus, stating that one metre thickness of each would have sufficed to give a register. He mentioned that the rotation of Venus is probably at least 15 days. The Einstein shift in the solar spectrum is still engaging attention. If present it is evidently partially masked by some other cause; the shift towards the red that is found is not proportional to wave-length.

The Society dined at the Criterion Restaurant in the evening. Lord Balfour was the guest of honour, and proposed the toast of the Society in felicitous terms, the president making a suitable reply.

On Wednesday the Fellows and Associates were the guests of the British Astronomical Association.

On Saturday, June 3, the Society was entertained by the Astronomer Royal at Greenwich on the occasion of the annual Visitation of the Observatory.

A. C. D. CROMMELIN.

University and Educational Intelligence.

LEEDS.—An open fellowship of 200*l*. per annum, established by the Institution of Gas Engineers, is offered for the prosecution of post-graduate research in gas chemistry. Applications will be received by the Registrar of Leeds University until June 19.

LIVERPOOL.—Honorary degrees were conferred at a special Congregation of the University held on May 19. The Bishop (the Right Reverend Francis James Chavasse), Mr. Justice Pickford (Baron Sterndale), and Sir Henry Alexander Miers, vice-chancellor of the University of Manchester, received the degree of doctor of laws; Dr. L. P. Jacks, Principal of Manchester College, Oxford, and Editor of the *Hibbert Journal*, that of doctor of letters, and Sir Charles Sherrington, Waynflete professor of physiology in the University of Oxford and president of the Royal Society, that of doctor of laws. For eighteen years Sir Charles Sherrington was the George Holt professor of physiology at Liverpool, and his services to the University College and University during that period are now remembered with deep affection and gratitude. The degree of doctor of engineering was conferred on Sir John A. F. Aspinall. Sir John Aspinall was for years chairman of the faculty of engineering at the University, and the present highly developed condition of the series of departments that now constitute the faculty is very largely due to the powerful influence that he exerted on its behalf. His professional career has seen the development of some highly important methods of modern railway transport.

LONDON.—The following Doctorates have been conferred:—*D.Sc. in Chemistry:* Mr. G. A. R. Kon, an internal student of the Imperial College—Royal College of Science—for a thesis entitled "The Influence of Space Conditions on the Formation of Strained Rings; The Formation and Stability of *spiro*-compounds." *D.Sc. in Cytology:* Mr. J. B. Gatenby, an internal student of University College, for a thesis entitled "The Cytoplasmic Inclusions of the Germ-cells: Part X.—The Gametogenesis of Saccocirrus." *D.Sc. in Physics:* Mr. L. C. Martin, an internal student of the Imperial College—Royal College of Science, for a thesis entitled "A Physical Study of Spherical Aberration." *D.Sc. in Physiology:* Miss Gladys A. Hartwell, an internal student of King's College for Women (Household and Social Science Department) and Bedford College, for a thesis entitled "Mammary Secretion." *D.Sc. in Botany:* Mr. W. J. Hodgetts, an external student, for a thesis entitled "A Study of some of the Factors controlling the Periodicity of Freshwater Algæ in Nature," and other papers.

Applications are invited for a Sharpey physiological scholarship at University College. The scholarship is of the value of 200*l*. Applications, with a full statement of the candidates' academic training and a list of their publications, if any, should reach the secretary of the college, Gower Street, W.C.1, not later than June 15.

A DRAPERS' COMPANY'S research scholarship in dyeing and a research scholarship in colour chemistry, tenable for the session 1922–23 at the Huddersfield Technical College, are offered. The value of the first-named scholarship is 100*l*. and remission of fees, and that of the last named not more than 100*l*. and remission of fees. All particulars and forms of application may be had from the secretary of the college.

Calendar of Industrial Pioneers.

June 10, 1850. James Smith died.—Educated at Glasgow University, Smith was placed in charge of his uncle's cotton-works at Deanston, Perthshire, where he introduced many improvements in manufacture and agriculture. He invented a reaping machine, improved the self-acting mule, built bridges and waterwheels, in 1813 lighted his factory by gas and introduced the sub-soil plough and the deep draining of soils.

June 11, 1843. Alexander Forsyth died.—The inventor of the percussion lock, Forsyth was born in 1769, graduated at King's College, Aberdeen, and from 1791 till his death was minister of his native place of Belhelvie. Devoting his spare time to chemistry and mechanics, in 1805 he brought out the percussion lock, which, though experimented with in the Tower of London, was not taken up by the Government. Forsyth refused an offer of 20,000*l.* from Napoleon for the secret.

June 13, 1847. David Mushet died.—A pioneer among modern metallurgists, Mushet began experimenting in the manufacture of iron and steel in 1793 while employed at the Clyde Iron Works. Dismissed through jealousy, he erected the Calder Iron Works, and while so engaged, in 1800 patented a process of making steel direct from iron in bars, and in 1801 made the discovery of the value of the black-band ironstone, which previously had been regarded as worthless.

June 14, 1768. James Short died.—In his day without a rival as a constructor of reflecting telescopes, Short was the first to give specula a true parabolic form. Born and educated at Edinburgh, where he learned mathematics from Maclaurin, he was summoned to London to give mathematical lessons to one of the royal family. He afterwards set up as an instrument maker in London.

June 14, 1874. Sir Charles Fox died.—Articled first to a doctor, Fox abandoned medicine for engineering, worked for Ericsson and Robert Stephenson, and became a partner in the firm of Fox, Henderson and Co., the first firm systematically to manufacture railway plant. Fox designed the buildings for the Great Exhibition of 1851, made the first narrow-gauge line in India, built the Berlin waterworks, and was connected with many railway enterprises.

June 15, 1905. James Mansergh died.—One of the greatest water-supply and sewerage engineers, Mansergh was responsible for works in some 60 or 70 towns at home and abroad. Among his most notable works were the Elan and Claerwen reservoirs in Wales, constructed for the Birmingham Corporation and opened by King Edward VII., July 21, 1904. In 1900 he served as President of the Institution of Civil Engineers.

June 15, 1915. Sir Nathaniel Barnaby died.—Barnaby came of a family of shipwrights, and was born at Chatham in 1829, the year the first British steam war-vessel was built. He was trained in the Royal Dockyard, and in 1870 succeeded Reed as Chief Constructor of the Navy, a post he held till 1885, when he was succeeded by White. To him were due many advances in the design and construction of warships; he introduced the use of steel, and during his regime sixty-six sea-going fighting ships of more than 2000 tons were built. The torpedo and torpedo boat came into use during his period of office, but he opposed the idea prevalent then, and periodically urged that the torpedo rendered the battleship obsolete.

E. C. S.

Societies and Academies.

London.

Royal Society, May 25.—Sir Charles Sherrington, president, in the chair.—C. H. **Lees**: The thermal stresses in solid and in hollow circular cylinders concentrically heated. The method of calculation is similar to that used in dealing with spheres. Two cases of practical importance are worked out—that of a furnace with the temperature throughout the wall steady, and that of a pillar supporting the floor above a room in which a fire occurs. Curves are given for the thermal stresses produced.—B. F. J. **Schonland**: On the scattering of β-particles.—N. K. **Adam**: The properties and molecular structure of thin films. Pt. II. Condensed films. Pt. III. Expanded films. Saturated and unsaturated fatty acids of the long straight chain series, and their derivatives, including esters, substituted ureas, an alcohol, amide, and nitrite have been studied. Below a certain temperature determined by the conditions, the molecules appeared to be closely packed or "condensed." Above this temperature greater areas on the surface were occupied, such films being called "expanded films." Two general types of condensed film were found: one in which the hydrocarbon chains are close packed, while in the other probably only the polar groups touch. In the temperature interval (about 25° C.) between fully condensed and fully expanded states, pressure-area curves resemble isothermals of a vapour near critical temperature. Probably expanded films resemble vapours in two dimensions. Increase in length of hydrocarbon chains raises the temperature of expansion regularly. The lateral attraction which tends to keep the molecules close packed therefore depends on the length of these chains. Probably the greater attraction between longer chains diminishes the area of the expanded films. The area actually filled by molecules both of saturated and unsaturated acids is probably nearly the same in expanded and in condensed films; therefore it is unlikely that the unsaturated linkage in oleic acid approaches the water closely, as was previously thought.—E. **Wilson**: On the susceptibility of feebly magnetic bodies as affected by compression. Rock specimens were examined and the compressive stress was necessarily limited to about 1200 kgm. per sq. cm. Some feebly magnetic alloys have also been tested. All the specimens are in the form of short bars about 4 cm. in length, with a cross-section either 1 cm. square or 1 cm. in diameter, and the compressive stress has been applied in the direction of the length of the bar. The susceptibility has been measured (*a*) in the direction of the stress and (*b*) at right-angles to it.—S. F. **Grace**: Free motion of a sphere in a rotating liquid parallel to the axis of rotation. The motion is a small disturbance from one of uniform rotation, like a rigid body due to a projection, parallel to the axis of rotation, of a sphere of density equal to that of the liquid and originally at rest relative to it. The path of the centre of the sphere is a straight line, and the motion is symmetrical about it. The sphere oscillates about a point with amplitudes which diminish rapidly, being less than 0·02 of the velocity of projection, after one revolution of the liquid. The velocity of the liquid in this line is oscillatory. The disturbance over the plane through the centre of the sphere perpendicular to the axis is oscillatory, and confined to the immediate neighbourhood of the sphere. The components of verticity contain terms proportional to the time, so that the assumptions of small motion are ultimately violated.

Society of Glass Technology, May 17.—Prof. W. E. S. Turner, president, in the chair.—J. **Currie**: Columnar structure in sandstone blocks. A glass tank furnace sprang a leak in the bottom and the metal drained through rapidly. A full heat of 1300° C. was maintained to facilitate the removal of the metal, but finally part of the crown of the furnace collapsed and the gas was cut off. After the tank was dismantled it was observed that the sandstones readily disintegrated into long prismatic columns, many of which were straight, but most of them showing a decided curvature. They were roughly pentagonal in section, and varied in thickness from 0·5-1·5 inches; some were trigonal, others tetragonal in form. The columns were intersected at more or less regular intervals by cross joints, so that the sandstone tended to break up into short columns five or six inches long, some of which were regularly prismatic, others tapering off to a point. The effect is probably due to the rapid expansion caused by the sudden increase of temperature from 800° C. to 1300° C. resulting from the break in the furnace, followed by sudden cooling when the gas was turned off. The formation probably started at the point of contact with the glass, and as has already been claimed for similar formations in Nature, columnar jointing is related to the planes of cooling.—F. W. **Adams**: Some practical notes on the manufacture of white glass in a tank furnace. It is necessary to have complete analyses of all batch materials used, especially the selenium decoloriser. The total iron content in the finished glass must be kept constant, and careful weighing and efficient mixing of the batch ingredients is essential. Melting temperatures should be kept constant by the use of pyrometers. Lehr temperatures should be correct for a given type of glass and kept constant. Two pyrometer stations in the lehr are advisable, and articles differing greatly in weight should not be put together in the same lehr. Selenium offers many advantages over other decolorising media, and will undoubtedly be as generally used in this country for making colourless glass as in the United States when the conditions for its application are more fully understood by manufacturers.

Royal Meteorological Society, May 17.—Dr. C. Chree, president, in the chair.—A. E. M. **Geddes**: Weather and the crop-yield in the north-east counties of Scotland. The methods of correlation have been applied to find the relation between the yield of the crops in the three north-east counties of Scotland and the "weather," including in this term temperature and rainfall. There is not sufficient uniformity in all the conditions over the area from Nairn to Fife to permit of useful deductions being drawn. The final investigation was confined to the counties of Aberdeen, Banff, and Kincardine for the period 1885 to 1919. The conclusions are as follows: cereals do better in a comparatively warm summer with rainfall somewhat in excess; root crops show less connection with the weather than cereals, but are better with rainfall below the normal; hay is influenced almost as much by the weather of the year previous as by that of the actual year of harvest. Comparing the latest values for eastern England for the same period, it appears that the most important sections of the year, so far as weather is concerned, vary from district to district. It is important not to make the district too wide in such investigations.—H. P. **Waran**: A new form of direct-reading barometer. The instrument is a modified syphon barometer that compensates automatically for the change of level. This is accomplished by reading axially through the inclined upper reservoir, the reflection on the mercury surface of the divisions of a short length of vertically suspended scale, which has once been set to read the actual pressure, on the cross-wire.

PARIS.

Academy of Sciences, May 15.—M. Albin Haller in the chair.—L. **Maquenne** and R. **Cerighelli**: The influence of lime on the yield of seeds during the germinative period. Traces of lime in the culture fluid (10 parts of calcium sulphate per million) favour the growth of the organs, and this is shown not only by increased length, as compared with control seeds grown in distilled water, but also by increase in weight.—Georges **Charpy** and Louis **Grenet**: Study of the penetration of tempering in steel. A method is described permitting the study of the variation in hardness (Brinell) along a bar, after tempering at different temperatures, with or without reheating, and not necessitating test pieces being cut out of the specimen.—Gustave **Guillaumin**: The equations of the limit of equilibrium of adherent bodies.—Jean **Chazy**: The movement of a planet in a resisting medium.—F. **Michaud**: The rigidity of jellies. A new method of measuring the rigidity of a jelly is described, based on the use of a horizontal tube filled with the jelly and carrying some solid particles in suspension, the movement of which, when the ends of the rod of jelly are submitted to different pressures, can be measured in a microscope. The apparatus has been applied to the measurement of the rigidity of 15 solutions of gelose of concentrations varying from 0·4 to 6 per 1000. The experimental figures can be expressed by the empirical formula $\mu = 6{\cdot}32\ (c - 0{\cdot}39)^{3{\cdot}3}$, where μ is the modulus of rigidity in C.G.S. units, and c is the number of grams of gelose per 1000 grams of the mixture.—Henri **Abraham** and René **Planiol**: A new method of emission doubling the capacity of wireless telegraphy stations.—A. **Grebel**: A comburimeter and a controller for gas, Grebel-Velter system. In the "comburimètre," the coal gas is burnt in air, the ratio of gas to air being capable of variation and measurement. A mirror surface of fused lead serves as the indicator for oxygen in excess, and the exact quantity of air required for the complete combustion of a given volume of gas is thus continuously indicated.—Mme. **Ramart** and M. G. **Albesco**: Study of the two $\alpha\alpha$. $\beta\beta$-substituted propiophenones and their reaction with sodium amide.—Marcel **Delépine**: The auto-oxidation of organic sulphur compounds. A detailed account of some phenomena observed when air and certain sulphur compounds (such as $SC(OCH_3)(S . CH_3)$; $CH_3 . CS . (OCH_3)$) interact. The observations cannot be fully explained.—Henri **Piéron**: The law of the velocity of establishment of the fundamental chromatic processes as a function of the intensity of the luminous stimulation.—Alphonse **Labbé**: The activation of the spermatozoid in heterogeneous fecundations.—Armand **Dehorne**: The formation of myolytic spindles and their phagocytosis in the cœlom of *Lipobranchus intermedius*. These organisms are extracted from old oyster shells by placing the latter in a crystallising basin filled with sea-water. The Lipobranchus can be seen swimming or attached to the sides of the basin. They are fixed living, and on microscopical analysis show marked phenomena of histolysis. It is remarkable that it is the muscles which show peculiar sensibility to this degeneration. The changes in the muscle fibres are described in detail.—C. **Gessard**: Varieties of pyocyanoid bacilli. The term "pyocyanoid" is applied to degenerate pyocyanic bacilli, which although retaining most of

their original properties have lost the essential characteristic of making pyocyanine. One variety gives no trace of the blue colouring matter in peptone water or peptone gelose, but the pyocyanine reappears if a small quantity of glycerol be added to the peptone gelose. In cultures with increasing quantities of glycerol, the power of producing the blue pigment is lost.—Albert **Berthelot** and Mme. **St. Danysz-Michel**: The presence of acetone-producing micro-organisms in the intestinal flora of diabetics. Cultures from fæcal matter of 32 subjects, not diabetic, but suffering from various diseases, showed that no organism was present capable of producing acetone from starch. From similar cultures with fæces from diabetic patients, acetone-producing organisms were found in 17 cases out of 22. The view that diabetes is a disease of microbial origin is not in agreement with the present state of knowledge of this disease, but it is not altogether impossible that certain cases of diabetes may be caused, directly or indirectly, by the presence of certain micro-organisms in the intestine.—M. **Breton** and V. **Grysez**: The reactions of defence and immunity provoked by the intradermic injection of micro-organisms, either living or killed by heat. The skin of the rabbit possesses exceptional properties of defence against organisms inoculated there: immunity has been produced by a single injection.

Official Publications Received.

Annals of the Astronomical Observatory of Harvard College. Vol 86, Part 1: Observations and Investigations made at the Blue Hil Meteorological Observatory in the Year 1921 under the direction of Prof. A. McAdie. Pp. 61. (Cambridge, Mass.)

Egyptian Government. Almanac for the Year 1922. Pp. viii+242. (Cairo: Government Publications Office.) P.T. 10.

Dominion of New Zealand: Board of Science and Art. Bulletin No. 2: History of the Portobello Marine Fish-Hatchery and Biological Station. By the Hon. Geo. M. Thomson and the late T. Anderton. Pp. 131. (Wellington, N.Z.)

Annual Report of the Council of the Yorkshire Philosophical Society for the Year 1921, presented to the Annual Meeting, February 13th, 1922. Pp. 51. (York.)

The Royal Society for the Protection of Birds. Thirty-first Annual Report, January 1st to December 31st, 1921, with Proceedings of Annual Meeting, 1922. Pp. 76. (London: 23 Queen Anne's Gate, S.W.1.)

Diary of Societies.

FRIDAY, JUNE 9.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section) AND BRITISH ASSOCIATION FOR THE ADVANCEMENT OF RADIOLOGY AND PHYSIOTHERAPY (at 1 Wimpole Street), at 10.30 A.M. and 2.30.—Congress of Radiology and Physiotherapy.

PHYSICAL SOCIETY OF LONDON, at 3.30.—Visit to the National Physical Laboratory, Teddington.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Major Sir Humphrey Leggett: Tanganyika Territory (formerly German East Africa).

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society).

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Dr. A. E. Trueman: The Liassic Rocks of Glamorgan.—C. C. Fagg: The Recession of the Chalk Escarpment and the Development of Valleys in the Chalk between the Mole and the Darenth.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—J. Barcroft: Physiological Effects at High Altitudes in Peru.

SATURDAY, JUNE 10.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section) AND THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF RADIOLOGY AND PHYSIOTHERAPY (at 1 Wimpole Street), at 10 A.M. and 2.30.—Congress of Radiology and Physiotherapy.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Hugh Allen: Early Keyboard Music (3).

MONDAY, JUNE 12.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Miss A. M. Hodgkin: The Witness of Archæology to the Bible.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society of London), at 5.30.—Dr. H. Chatley; A. S. E. Ackermann: The Physical Properties of Clay.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Business Meeting.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—T. Greenwood: Geometry and Reality.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall, 135 New Bond Street), at 8.30.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section), at 8.30.—Sir Leonard Rogers: Leprosy: its Etiology and Epidemiology.—D. Pinnock: Quinine Necrosis of Muscles.—Dr. J. Bamforth: Cortical Necrosis of the Kidney in a Fatal Case of Malaria.

TUESDAY, JUNE 13.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. G. Holmes: The Symptoms of Cerebellar Disease and their Interpretation (Croonian Lectures) (2).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: The Council's Scheme to establish an Aquarium in the Society's Gardens.—Miss Joan B. Proctor: A Study of the Tortoise *Testudo loveridgii*, Blgr., and the Morphogeny of the Chelonian Carapace.—J. T. Carter: A Microscopical Examination of the Teeth of the Primates.—H. G. Jackson: A Revision of the Isopod Genus Ligia (Fabricus).—W. R. B. Oliver: A Review of the Cetacea of the New Zealand Seas.—Prof. Wood Jones: The Dental Characters of certain Australian Rats.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. T. Usher: Matt Surface Plates.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—E. K. Maxwell: Some Tubular Rotifers.—F. H. Davidson: Demonstration of Microscope and Super-Microscope.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. G. Elliot Smith and Prof. J. I. Hunter: A Reconstruction of the Piltdown Skull.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Dr. F. L. Hopwood and Dr. E. A. Owen: German Apparatus for the Production and Measurement of X-rays for Deep Therapy.—Prof. S. Russ and L. H. Clark: A Balance Method of Measuring X-rays for Therapeutic Purposes.—Dr. F. L. Hopwood: The Ondoscope.—Dr. E. A. Owen: The Sphere Gap Voltmeter.

SOCIOLOGICAL SOCIETY (at Royal Society), at 8.15.—G. K. Chesterton: The Return of the Guilds.

WEDNESDAY, JUNE 14.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. P. G. H. Boswell: The Petrography of the Cretaceous and Tertiary Outliers of the West of England.—Prof. W. N. Benson and Dr. S. Smith: Some Rugose Corals from the Burindi Series (Lower Carboniferous) of New South Wales.

ROYAL MICROSCOPICAL SOCIETY, at 8.—J. Strachan: The Microscope in Paper Making.—A. Chaston Chapman: The Use of the Microscope in the Brewing Industry.

THURSDAY, JUNE 15.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Dr. H. M. Evans: The Defensive Spines of Fishes, Living and Fossil, and the Glandular Construction in connection therewith, and Observations on the Nature of Fish Venoms.—D. W. Cutler, L. M. Crump, and H. Sandon: A Quantitative Investigation of the Bacterial and Protozoan Population of the Soil: with an Account of the Protozoan Fauna.—D. W. Devanesen: The Development of the Calcareous Parts of the Lantern of Aristotle in *Echinus miliaris*.—Dr. A. Lipschütz, C. Wagner, R. Tamm, and F. Bormann: Further Experimental Investigations on the Hypertrophy of the Sexual Glands.

LINNEAN SOCIETY OF LONDON, at 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. G. Holmes: The Symptoms of Cerebellar Disease and their Interpretation (Croonian Lectures) (3).

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Lieut.-Col. A. Ogilvie: Some Aspects of Aeronautical Research (Wilbur Wright Lecture).

NATIONAL UNION OF SCIENTIFIC WORKERS (in Botanical Theatre, University College), at 5.30.—F. W. Sanderson: The Duty and Service of Science in the New Era.

CHEMICAL SOCIETY, at 8.—C. K. Ingold and E. A. Perren: Ring-chain Tautomerism. Part III. The Occurrence of Tautomerism of the Three-carbon (Glutaconic) Type between a Homocyclic Compound and its Unsaturated Open-chain Isomeride.

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

FRIDAY, JUNE 9.

UNIVERSITY COLLEGE, at 5.30.—Prof. E. Husserl: Phänomenologische Methode und Phänomenologische Philosophie (3). (In German.)

MONDAY, JUNE 12.

ROYAL SOCIETY OF MEDICINE, at 5.—Dr. M. Jansen: Injurious Agents and Growth. (In English.)

UNIVERSITY COLLEGE, at 5.30.—Prof. E. Husserl: Phänomenologische Methode und Phänomenologische Philosophie (4). (In German.)

TUESDAY, JUNE 13.

FELLOWSHIP OF MEDICINE (at 1 Wimpole Street), at 5.—Sir William Hale White: The Clinical Symptoms of Coli Infection of the Urine.

KING'S COLLEGE, at 5.30.—C. E. M. Joad: Vitalism Restated (2). Dualism and the Life Force.

THURSDAY, JUNE 15.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 5.—Prof. C. H. Reilly: Some London Streets and their Recent Buildings.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Sir Berkeley G. A. Moynihan: Diverticula of the Alimentary Tract.

SATURDAY, JUNE 17, 1922.

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The Genesis of the World.

"WHENCE sprang this world, and whether framed
By hand divine or no—"

are questions that have fascinated and perplexed the greatest thinkers of every age, or at least since man reached such a level of intellectual evolution that he could speculate about them. If we may reason from our knowledge of the mentality of the lowest grades of humanity as we know them to-day, it is reasonably certain that man must have existed on the earth for æons before he attained to a degree of mental development that would enable him to give the slightest consideration to such matters. Anthropologists tell us that even in this twentieth century there are races of men, situated in remote and widely separated regions of the world, who have never framed, and, so far as can be discovered, have never attempted to frame, any conception or surmise concerning its origin. And yet these races are as far removed in development from the prehistoric man as the prehistoric man was from the ape.

It is nevertheless true that thousands of years before the beginning of our era there were some whose mental powers enabled them to ponder upon the problem, and to attempt to form the beginnings of a theory of creation which should in some measure satisfy their curiosity and reasoning faculty. But these people existed comparatively late in the history of mankind, and still later in the history of the world. We are apt to think that the legends of Brahma, the spirit who created by his will and the mere exercise of thought the primeval water, the primordial element out of which the world was fashioned, date from the remotest periods of antiquity. This is not so, as we now reckon the age of the world, or the time that man has existed upon it.

It is far from our present purpose to attempt to trace, however slightly, the broad outlines of the growth of knowledge and speculation concerning the genesis of the world—from the myths of primitive races down to our times, when the great enigma is being attacked by modern methods of research and in the light of contemporary science. The subject is too vast to be handled within the narrow confines of an article such as this. But it may be worth noting how characteristic is the difference between the modern methods and the old. The earliest cosmogonies were based upon conceptions which were really incompatible with the experiences of those who framed them. These conceptions must have been repugnant to the intelligence of all who were alive to the teachings of natural phenomena, or refused to blind their reason at the behests of the priests by whom the myths were devised. In one respect the speculations, or at least some of them, may be said to be so far scientific in that they contain the

germ of the theory of evolution. But they all presupposed the action or intervention of supernatural forces, and as such had no real scientific basis. Purely metaphysical speculation leads nowhere, and the unsubstantial subtleties of dialecticians leave us cold. We seek to elucidate what has been for countless ages an inscrutable problem in the light of the lessons of physical science. We reason from the facts of astronomy, geology, physics, chemistry, and biology as we know and understand them, and as each new development arises we apply its teaching to the solution of the mystery. It has already been pointed out that the application of the mechanical theory of heat, spectrum analysis, thermal radiation, radiation pressure, and radio-activity to cosmogonic phenomena has done more to elucidate these problems than all the speculative theories and systems of former ages put together.

The lecture[1] which Prof. Nernst reprints in the little brochure before us is, we believe, the latest attempt to focus the outcome of modern research upon this question of the origin and mode of formation of the world. He applies to it the knowledge with which his study and training as a worker and expositor of chemical physics has equipped him. Furthermore, he has sought the aid of students in fields of inquiry other than his own when these have any direct relation to his subject. The lecture was originally delivered in Berlin as one of a series of popular discourses arranged by the Prussian Academy of Sciences about a year ago, and has been repeated in parts of mid-Europe, notably in Vienna and in Prague. As published it has been considerably enlarged. It is prefaced by a short introductory statement defining the problem and explaining its limitations, and the methods by which it may be attacked. It is furnished with a long appendix, practically as extensive as the lecture itself, in which details are developed which would be out of place in a purely popular exposition. As may be anticipated, the whole is instructive and highly suggestive, and we have read it with interest and pleasure. Nevertheless we rise from its perusal with a humbling sense of the inadequacy of our present means to grapple with so stupendous a problem. More than ten years ago the same theme was handled by Prof. Svante Arrhenius in his "Werden der Welten" and afterwards in "The Life of the Universe," and it may be doubted whether in reality Prof. Nernst has succeeded in carrying the matter any further. How partial and inadequate is the basis on which even the latest cosmogony rests was well brought out in the discussion last year at the Edinburgh meeting of the British Association on the age of the earth. The work of one epoch does little more than upset that of its predecessor. Premises in regard to the earth's heat are vitiated by the discovery of radio-active materials. We are still in ignorance as to the true source of solar energy. Secular contraction apparently is not enough to account for it. We have absolutely no definite knowledge on so fundamental a matter. The more we learn the greater seems our ignorance. We can but go on groping for the light, testing our surmises as best we may in the feeble glimmer that our present knowledge sheds.

Negligible as is the scientific merit of the old cosmogonies, they had at least the charms of imagery and fancy—charms at which the cold, unsympathetic eye of a passionless science looks askance. Even the imagination of a Tyndall would find it difficult to invest our modern cosmogony with the vestiges of such attributes.

[1] "Das Weltgebäude im Lichte der Neueren Forschung." Von Prof. Dr. W. Nernst. Pp. iv+63. (Berlin: Julius Springer, 1921.) In Germany, 12 marks; in Great Britain, 48 marks.

Textile Research Fellowships.

THE British Research Association for the Woollen and Worsted Industries represents the culmination of a movement which was started at the University of Leeds during the early days of the war. Two objectives were then in view, research specially applied to the elucidation of problems presented by the textile industries, and a deeper and more extensive education with the object of promoting the introduction of the sciences and scientific method into industry whenever and wherever possible. It was perhaps natural that the first of these objectives should dominate when, in what it conceived to be the larger interest of the community, the University handed over its missionary work to the newly constituted Research Association, which included representatives from the whole of the woollen and worsted industries of Great Britain and Ireland.

The experience of this association is now tending to emphasise the need for well-trained, sympathetic men actually placed in the works if the achievements in research—which already are by no means inconsiderable—are to be used at all: still more is this necessary if anything like full value is to be drawn from research results.

It is therefore not surprising that the research association should consider it not only expedient but also absolutely necessary that well-trained University and other students should be encouraged to resist the more direct call of industry and to prepare themselves for the difficult but very necessary work of introducing more science into industry. Whether this appeal will achieve the desired result depends not only upon the fellows and scholars which the association is now selecting, but also upon the sympathetic consideration given to their work and its possibilities by the controllers of industry. In addition to ability, there must

be opportunity, and only the combers, spinners, and manufacturers can give this.

We have confidence that the necessary opportunity will be given to the well-trained man, and we therefore specially direct the attention of those eligible for the fellowships and scholarships offered by the British Research Association for the Woollen and Worsted Industries. In each case awards are tenable in the first place for one year, and maintenance grants are offered, the maximum value of the fellowships being fixed at 200*l.* per annum. Applications for fellowships, which should reach the secretary of the association at Torridon, Headingley, Leeds, before June 30, should contain full particulars of the candidates' training and an outline of the research which it is proposed to undertake. It should be realised, however, that if success is to be achieved a type of "researcher" different from any yet produced is necessary. The man of science has as yet made little or no direct impression upon the woollen and worsted industries; all the advances made —and these have been more considerable than most people realise at the present moment—have been at the hands of the technologist. Indeed, it is still a moot point as to whether the technologist should be encouraged to obtain a training in pure science, or whether the man of science should become a technologist. Possibly both these lines of action are promising, but from the scientific point of view it is very desirable that prospective candidates should have a sound knowledge of the industry, for with this knowledge and deeper insight will undoubtedly come a profound respect for an industry which has already achieved so much, and further an earnest desire to help towards increasing its usefulness in the service of humanity.

Possibly the textile industries offer most promising fields of research in the direction of physical chemistry; but applied mathematics, chemistry, zoology, and other of the sciences have also claims which will certainly not be ignored.

A Manual of Tides.

Tides and Tidal Streams: A Manual compiled for the Use of Seamen. By Comdr. H. D. Warburg, R.N. Pp. vii+95. (Cambridge: At the University Press, 1922.) 8*s.* 6*d.* net.

THE author of this manual is convinced, and not without cause, that the non-harmonic methods of giving and using tidal information at ports not served by complete predictions are obsolete and not trustworthy. These methods assume the simple phenomenon of semi-diurnal tides only and came into prominence because the original workers on tides were most familiar with the tides in European waters. But in most parts of the world the diurnal tides cannot be neglected, even if they are not of greater importance than the semi-diurnal tides, and at present navigators are not provided with information suitable for the calculation of tidal heights in such places. Commander Warburg suggests that the tides should be represented universally by a few harmonic constituents, and that navigators should be taught suitable methods for getting approximate values of the height of tide at any time by the use of harmonic methods.

The author gives an explanation of the generation of tides and tidal currents as an introduction to the harmonic methods proposed, and he also explains various tidal phenomena such as the double high-waters experienced on the south coast of England, but these explanations cannot always be commended from the scientific point of view. The phenomenon of double high-waters, incorrectly explained in the manual, has often been explained correctly from Airy onwards (*e.g.* Sir W. Thomson, NATURE, Dec. 19, 1878), but the wrong explanation is curiously persistent. It is alleged that the cause is in the reflection of the tide wave from the north coast of France and that this "reflected wave" arrives on the south coast of England some six hours later than the "primary wave"; we thus get, it is said, two waves with their maxima some six hours apart and therefore two high-waters within six hours of one another. But obviously, or at least from simple trigonometry, two semi-diurnal oscillations, whatever be their relative phases, can only combine to give a semi-diurnal oscillation; that is, the part played by reflection is to make the resultant phase of the actual oscillation at a given place different from what it would have been if no reflection had taken place. The true cause is the presence of quarter-diurnal oscillations in the primary wave. These are due chiefly to shallow water, and with a free unreflected progressive wave the phases of the semi-diurnal and quarter-diurnal oscillations are such that double high-waters cannot occur; but if reflection takes place then it is possible to disturb this phase relationship so that the minimum of the resultant quarter-diurnal tide occurs about the time of maximum of the semi-diurnal tide; we may then get a "double-headed tide," or a very long "stand." The importance of the shallow-water constituent is, however, not limited to double high-water phenomena, which are only extreme cases.

A brief explanation of the mechanical harmonic method of calculating predictions is given, but the diagram of a tide-predicting machine, however, illustrates motions which are not strictly harmonic. The

author might justly complain that a similar diagram has been allowed to pass for several years without comment in the Admiralty Tide Tables!

For the calculation of approximate predictions Van der Stok's scheme of calculation is explained and used in the book, and the calculations are facilitated by appropriate tables. Some little confusion is caused, however, by using the same symbol (k) for the phase-lag (in degrees) and time-lag (in hours) when the tidal constituent is referred to a fictitious satellite; it is customary to use κ for the phase-lag. It is doubtful whether it was wise to depart from the usual rule of stating the astronomical argument; it is customary to make the speeds positive and the arguments therefore increase with time. Except to those using the harmonic method for the first time there is a liability of confusion between theory and practice, a positive speed and a decreasing argument being difficult to reconcile. If, however, the instructions are carefully followed the required predictions can be readily obtained, whether there is much or little diurnal tide.

It ought to be added that a criterion given for the relation between semi-diurnal and diurnal tides so that one maximum per day only can occur, has a very limited application.

The manual gives authoritative explanations of the non-harmonic methods of collecting and using tidal information. In spite of the blemishes mentioned above, the book should serve a useful purpose in making seamen acquainted with the reasons why such methods are often futile. At the same time, it provides an alternative and more exact method, and in doing this Commander Warburg has initiated a movement which, we hope, will lead to much-needed reforms in the everyday applications of tidal science.

A. T. DOODSON.

Electrothermic Processes in Steel Manufacture.

The Electro-Metallurgy of Steel. By C. C. Gow. (A Treatise of Electro-Chemistry. Edited by Bertram Blount.) Pp. xvi+351. (London: Constable and Co., Ltd., 1921.) 27*s*. 6*d*.

WHAT are usually called electro-metallurgical processes of steel manufacture now constitute an applied science of considerable industrial importance. Strictly speaking, however, the processes are not electro-metallurgical since electrolysis is not an essential feature. Electrical energy is transformed into heat energy which is applied to the making and refining of steel of many types. The possibility of applying electrical energy in this way was first demonstrated by the late Sir William Siemens almost twenty years before its commercial possibilities were recognised by later investigators. Prior to the outbreak of the late war the electric furnace had only a very limited application in steel metallurgy. Since then it has had a rapid and vast development, due partly to the shortage of high-grade raw materials, partly to the enormous demand for alloy steels, and partly to the need for utilising in some way the vast accumulation of heavy steel turnings. These conditions presented an exceptional opportunity for the electric furnace, and it was only then that its economic advantages in certain branches of steel-making were actually demonstrated. According to Mr. D. F. Campbell, who has written a preface to Mr. Gow's book, the electric furnace is now absorbing millions of electrical horse-power for various purposes and has produced more than a million tons of steels of various types.

Mr. Gow is well fitted to write a book on electrothermic processes of steel manufacture, both on account of his scientific training and his wide experience of steel works practice. These qualifications have stood him in good stead in producing a book which should attract the attention both of students of metallurgy and practical steel-makers. Following an introductory chapter on the historical development of electric steel furnaces, the early chapters deal with the general principles and application of alternating currents. In writing these the author expresses his great indebtedness to Mr. R. P. Abel. Then come chapters on electrothermal methods of melting and refining cold charges and refining liquid steel, and these in their turn are followed by a chapter on ingot casting. Later chapters deal with characteristic principles and features of electric furnace design and modern types of furnaces, suitable refractory materials, and the properties and manufacture of carbon electrodes. Finally, there is an appendix detailing rapid methods of analysis of bath samples.

The melting of steel on a large scale in a strictly reducing atmosphere is possible only in the electric furnace. New phenomena are observed and striking results have been obtained. It is therefore correct to say that the electric furnace gives the steel-maker and refiner a new atmosphere in which to conduct his operations. Owing primarily to the much higher temperatures which can be reached, steels of inferior grade can be melted and their deleterious constituents to a great extent removed, because it is possible to introduce refining slags which can be fused and operated only at temperatures reached in the electric furnace. This type of furnace has now rendered available new alloys of special value, such as low carbon ferro-chromium, and high-grade ferro-silicon, which in their turn have

been economically transformed into products such as stainless steel, stainless iron, and transformer iron. The use of the last named has increased the efficiency of electric transformers to an extent which represents an annual saving of hundreds of thousands of tons of coal per annum.

At one time the induction furnace received considerably greater prominence than the arc furnace. As the author states, many furnace designers, believing that the principle of induction heating was superior, concentrated their efforts on the production of a furnace which could operate on any standard electric supply and at the same time meet all the requirements of the steel-maker. The position to-day, however, is that almost the entire output of electric steel is made from arc furnaces. The book is clearly printed and well illustrated and will certainly repay study by all those interested in the subject.

Physiology of the Growing Plant.

Encyclopédie scientifique: Bibliothèque de Physiologie et de Pathologie végétales: Nutrition de la plante. Par M. Molliard. I. Echanges d'eau et des substances minérales. Pp. xiv+395. II. Formation des substances terraires. Pp. vi+438. (Paris: Gaston Doin, 1921.) 14 francs each vol.

A SERIES dealing with the physiology of the growing plant in health and disease is being written by Prof. Molliard, Dean of the Faculty of Science of the University of Paris, and the two volumes under notice are the first to be issued. The scope of the series is wider than would usually be undertaken by a single writer, but the author considers that the advantages of uniform treatment will outweigh the disadvantages arising from the attempt to cover so extensive a field of science.

The volumes before us deal with the nutrition of the plant, the phenomena of absorption of nutrients from the soil, the building up of complex substances in the plant and their translocation from leaves to storage organs. The author has succeeded in bringing together a great amount of material that cannot usually be found in the same book, and this will prove a convenience to students. As an example, under the heading "Glucosides" there is not only the usual chemical account of these substances, but illustrations of cross-sections showing the distribution of typical glucosides in growing plants. In this and in other directions, the volumes give to the chemist much information that he does not possess although it may be well known to the botanist, and they give to the botanist a survey of chemical relationships which he might not find so easily elsewhere.

It could scarcely be expected that a book covering so much ground could include anything like all the recent work. The section on soils, for example, contains no reference to many of the investigations made during the last few years. The only grouping of fractions in mechanical analysis of which mention is made is that of Wollny, drawn up forty years ago, no reference being made to the important later developments made in the United States, Great Britain, Sweden, or elsewhere. Similarly also, it is assumed that soil possesses the sand-grain structure formerly attributed to it, although this view is now displaced by the later colloidal hypothesis. Fuller justice is done, however, to recent French work, and it is in the summaries of some of these interesting and suggestive investigations that English readers will find the chief interest of the book.

We should like to suggest that in future volumes there should be more references showing the sources from which the tables are taken. A considerable number of figures are given, but it is not easy to know the exact conditions under which they were obtained, and, as every one who has studied plant nutrition is aware, the phenomena are profoundly affected by alterations in the conditions under which the plant is growing. In particular the section dealing with the mineral constituents of plants would have been greatly improved by fuller references.

Life among the Sema Nagas.

The Sema Nagas. By J. H. Hutton. Published by the direction of the Assam Government. Pp. xviii+463. (London: Macmillan and Co., Ltd., 1921.) 40*s*. net.

MR. HUTTON has quickly added to his monograph on the Angami Nagas a second describing the allied tribe, the Sema. The latter occupy the watershed dividing Assam from Burma, the plateau and the valleys of three rivers, the most important, the Dayang, eventually flowing into the Brahmaputra and so into the Ganges, the other two mingling their waters with the Lania, and reaching the sea by way of the Ti-Ho, the Chindwin, and the Irawadi. The Sema Nagas are a mixed race, the result of emigration from at least three directions: from the north-west, whence came the Singpos, Kacharis, and Garos; from the south the Angamis; while a migration from south northwards on the part of the Thado Kukis and Lusheis has scarcely ceased even now.

Mr. Hutton's work is the result of eight years' acquaintance with the Sema Nagas, during which he learned to speak their language, which had not hitherto been reduced to writing, and gained the confidence of a

semi-savage people. He has thus had the opportunity of producing a fine, original work in ethnography, his memoirs being more elaborate than the other volumes of this excellent series which we owe to the enterprise and liberality of the Government of Assam.

Previous writers have found little that is favourable in the character of the Sema, and speak of their cruelty in war, their treachery and habit of lying. But Mr. Hutton, himself an Irishman, describes them as the Irishmen of the Naga race, generous, hospitable, and frequently improvident, impulsive and cheery, if easily depressed quickly regaining their spirits, readily moved to laughter and merriment under the most unpleasant conditions, while they still preserve a strong vein of fatalism. Their physical endurance in carrying heavy loads for long distances, in bearing cold and exposure, is remarkable, and in warfare and hunting, at any rate by Naga standards, they are plucky and daring. Their women, in appearance stumpy, plain or even ugly, are cheerful, faithful wives and dutiful daughters. Their art is limited to the decoration of their dress, weapons, and the Genna posts which mark the taboo limits of their villages.

As is usually the case with semi-savage tribes, the Sema live under a rigorous system of taboos, much more restrictive than those of the Hindu caste system. This type of taboo, known as Genna, is largely regulated by the agricultural seasons, and is enforced at sowing, harvest, and other farming operations. On such occasions work is suspended and special diet with numerous other trivial restrictions is enforced. They believe in a Creator, vaguely conceived, who interferes little in the affairs of men, in spirits of the sky and of the wild, spirits which cause delirium, spoil the crops and breed strife and quarrels, the spirits of the dead which fetch the living when they die. The basis of society is not the tribe or the clan, but the village, and they have evolved an elaborate system of social law. They manufacture for their own use excellent cotton cloth, not using fibres as the Angami do. Iron work is of recent introduction and follows methods borrowed from adjoining tribes. In spite of this advancement in social and industrial culture, head-hunting, success in which entitles the hero to wear gauntlets decorated with cowry shells and a collar of pigs' tushes, prevails, and the heads of women are specially valued, probably because they are secured with difficulty, women working only near the village in time of danger.

Mr. Hutton has described this strange type of society with wide knowledge and sympathy. His book is comprehensive, well arranged and supplied with maps and illustrations. Mr. H. Balfour, who writes a foreword, does full justice to it as an ethnographical study, and he informs us that Mr. Hutton has liberally presented to the Pitt Rivers Museum the greater part of his fine collections, an important gift to his old University.

More Books on Relativity.

A Criticism of Einstein and his Problem. By W. H. V. Reade. Pp. vi + 126. (Oxford: B. Blackwell, 1922.) 4*s.* 6*d.* net.

Relativity for All. By Herbert Dingle. Pp. viii + 72. (London: Methuen and Co., Ltd., 1922.) 2*s.* net.

Einstein and the Universe: A Popular Exposition of the Famous Theory. By Charles Nordmann. Translated by Joseph M'Cabe. Pp. 185. (London: T. Fisher Unwin, Ltd., 1922.) 10*s.* 6*d.* net.

Le Principe de Relativité et la Théorie de la Gravitation. Leçons professées en 1921 et 1922 à l'École polytechnique et au Muséum d'Histoire naturelle. Par Prof. J. Becquerel. Pp. ix + 342. (Paris: Gauthier-Villars et Cie, 1922.) 25 francs.

La Théorie einsteinienne de la Gravitation: Essai de vulgarisation de la théorie. Par Prof. Gustave Mie. Ouvrage traduit de l'allemand. Pp. xi + 119. (Paris: J. Hermann, 1922.) 4·50 francs.

L'Éther actuel et ses précurseurs (simple récit). Par E. M. Lémeray. Préface de L. Lecorme. Pp. ix + 141. (Paris: Gauthier-Villars et Cie, 1922.)

Raum und Zeit im Lichte der speziellen Relativitätstheorie. Versuch eines synthetischen Aufbaus der speziellen Relatitivätstheorie. Von Dr. C. Von Horvath. Pp. v + 58. (Berlin: Julius Springer, 1921.) England, 36 marks; Germany, 12 marks.

THE stream continues. Here are seven more books on relativity. It is difficult to know where to begin in commenting on such a collection. Mr. Reade's perhaps may be dismissed with a word; it ought not to have been written. Mr. Dingle's, on the other hand, is a serious little book by one who has caught the spirit of the matter. Within the limits of seventy small pages, without any mathematical symbols, he has done as well as can be expected in suggesting the various strains of thought that go to the making up of the theory. It is neither extravagant nor childish; it gives enough and not too much emphasis to illustrative analogies. The reader of this account may be assured that he is not being misled.

M. Nordmann's work, to which Viscount Haldane contributes a preface, is a much more ambitious production than that of Mr. Dingle and calls for more lengthy comment. To quote from the preface:

"The Latin capacity for eliminating abstractness from the description of facts is everywhere apparent. . . . This book could hardly have been written by an Englishman. The difficulty in his way would have

been one as much of spirit as of letter. It is the lucidity of the French author, in combination with his own gift of expression, that has made it possible for the translator to succeed so well in overcoming the obstacles to giving the exposition in our own tongue this book contains. The rendering seems to me, after reading the book both in French and in English, admirable."

The book is certainly readable. The language is not only clear, but also picturesque. "Einstein may be a treasure, but there is a fearsome troop of mathematical reptiles keeping inquisitive folk away from it. Let us drive them off with the whip of simple terminology, and approach the splendour of Einstein's theory." This is the author's intention, like that of many others ; how does he succeed ?

In the first two chapters we may admit a considerable success. Here due recognition is given to the valuable work done by Poincaré in preparing the minds of physicists for the theory by his insistence on the relativity of space. The reader is brought to the point of seeing the confusion wrought by the unexpected result of the Michelson-Morley experiment.

At the third chapter the author begins to feel the excitement of Einstein's new thoughts, and gives us a version of the explanation advanced in 1905 of the true significance of the Fitzgerald contraction-hypothesis. With the gesture of a conjurer he produces a "simple" version of Einstein's argument, remarking, however, that its elementary simplicity has not been attained without difficulty. Unfortunately the explanation advanced has nothing whatever to do with the argument of Einstein or the Fitzgerald hypothesis, but refers to the first order effect which would arise if the old theory were true. Later in the chapter the footnote giving as the best definition of the second, "the time which light takes to cover 186,000 miles in empty space, far from any strong gravitational field" suggests again quite a wrong view to the unwary and inexperienced reader. In spite, however, of these inaccuracies the writer does convey something of the impression of the insufficiency of the old absolute time and space ideas, and describes the situation thus : "We have before our eyes merely a battlefield strewn with corpses and ruins." "Time and space lie, torn and crumbled, among the rubbish of ancient theories."

Now comes the task of describing in "simple terminology" the work of reconstruction. The reader must judge whether the following is simpler than a brief algebraic equation : "The distance in time and the distance in space are numerically to each other as the hypotenuse and another side of a rectangular triangle are to the third side, which remains invariable. Taking this third side for base, the other two will describe above it, a triangle more or less elevated according as the velocity of the observer is more or less reduced. This fixed base is a quantity independent of the velocity. It is this which Einstein has called the '*Interval*' of events." A few lines later we read that this interval is the "sole perceptible part of the real. Apart from it there is nothing we can know." With this the writer passes on to the next chapter. Here the mechanics arising out of the restricted principle of relativity is described clearly and without rhetoric.

We have now to see how the author deals with the generalised relativity and its consequences. If the reader has digested the idea of interval so rawly presented to him in the early chapter, and has not the quickness to perceive that this has not been extended to the generalised theory, he may get a general impression from the next two chapters which is of the right type, but which again is far from accurate in detail. It appears from the account given that the only new feature in this stage is the introduction of gravitation. Not a word is said about the application of the general doctrine that all physical laws must have a form which is independent of the arbitrary choice of variables in the four-dimensional continuum. The mathematical reptiles are certainly driven off, and the treasure is not only left unguarded but it disappears. What is left is not the genuine article. Here again there are inaccurate statements, *e.g.* "the universe is not Euclidean because in it light does not travel in a straight line."

It is no pleasure to write thus critically of a valiant attempt to bring this theory into a form suitable for the layman. It is a supremely difficult task that is being attempted by so many writers. M. Nordmann is well equipped in many ways for it. But he has fallen into the very common error of supposing that the essential truth can be given while omitting the demand for concentrated thinking on vital details. The world suffers far too much from loose thinking already. Vague generalisations, misleading analogies, superficial manifestations are made to do duty for precise statements, logical reasoning, and fundamental principles. It is not necessarily true that mathematical skill is the only way of approach to an understanding of Einstein's fundamental ideas. But it is certain that if such an understanding is to be reached it can only be by going down to a patient analysis of our own preconceived notions until we find them insufficient. Einstein's success has come from a deep-rooted conviction that those thinkers were right who would not admit that a point in empty space could be labelled "stationary" or "moving uniformly in a straight line." He followed the logic of his conviction

and achieved fame. It was accuracy and honesty of thought which carried him through.

Prof. Becquerel gives us a text-book of the whole matter for those who are prepared to go into the complete mathematical presentation. There is nothing original; it is a plain and unvarnished account of the theory as it stands, including the generalisations of Eddington and Weyl. We may note that the author adopts the general conclusion that the gravitational field is the manifestation of the non-Euclidean character of the structure of the Universe, and that mechanics and physics are reduced to geometry. Is it not time that this statement should be examined more carefully? It suggests that the cart is pulling the horse and that the concrete arises out of the abstract, the known out of the unknown. When the physicist lapses into metaphysics he is apt to leave his terms undefined.

Of the remaining books before us we may briefly say that Prof. Mie's is a French translation of a German pamphlet recently noticed in these columns, that M. Lémeray traces the history of the rise and fall and ultimate extinction (as he seems to consider it) of the idea of the "ether," and that Dr. von Horvath has thought it well to try to give a new presentation of the restricted principle of relativity.

E. CUNNINGHAM.

Principles of Spectacle Design.

Handbuch der gesamten Augenheilkunde. Begründet von A. Graefe und Th. Saemisch, fortgeführt von C. Hess. Herausgegeben von Th. Axenfeld und A. Elschnig. Dritte, neubearbeitete Auflage. *Die Brille als optisches Instrument.* Von Prof. Dr. M. von Rohr. Dritte Auflage. Pp. xiv+254. (Berlin: J. Springer, 1921.) In Germany, 66 marks; in England, 132 marks.

SINCE the first edition of this work appeared ten years ago, the design of spectacles has undergone important developments which are attributed by the author to the increased competition of large specialist manufacturers, to the interest of ophthalmologists and technical scientific workers, and to recent war experience.

The work is worthily dedicated to Allvar Gullstrand, upon whose optical treatment of the subject the theoretical portions are based, and more particularly those sections concerned with the eye in motion. It deals in a thorough and comprehensive manner with the comparatively simple geometrical principles involved in the design of spectacles for the correction of abnormal vision, but, as is clearly stated in the preface, it does not enter the sphere of the optical computer to whom the practical design is entrusted.

Those who are interested in the theoretical problems of spectacle design will find in this work a clear exposition of most aspects of the subject. The formulæ as well as the diagrams can be relied upon, as they are particularly free from errors. An introductory section deals with spectacles of various materials for special purposes. Section I. is devoted to anastigmatic lenses for both fixed and moving eyes. Section II. deals with astigmatic lenses, under which are included the various toric forms and combinations. In Section III. chromatic aberrations are considered, and apparent aberrations in the image space resulting from vision through spectacles are discussed in the concluding section. Although excellent source, name, and subject indexes are provided, there is unfortunately no index of the symbols employed. The systematic historical index of the first edition has been dispensed with, as the information is included under the various subject headings.

Nearly one-half of the text is devoted to historical references which increase the general interest of the work. As the author states in his preface, the desire to recognise the true inventor lies close to his heart. The task is a difficult one, and, if the author has failed in some respects, it may be attributed to a too ready use of German sources of information. The historical notes do not extend much beyond 1917, although, according to the title-page, the edition dated 1921 is stated to have been newly revised. Indeed, there is only one reference as recent as 1920. An English author is pilloried (p. 114) for the absurd accuracy of certain numerical data, but the author himself, in many instances records to within 1/1000 mm. ocular dimensions that are comparatively indefinite.

There is a tendency throughout the work to sacrifice clearness to generality. Spectacles, for example, are inadequately defined as "optical instruments that can be carried continuously before the eyes," the object being not to exclude extreme cases such as protective glasses for stone-hewers, spectacles for drivers, and those in which use is made of mica, horn, and other substances. But the reader will find more in this book by Dr. M. von Rohr for warm approval rather than for criticism.

JAMES WEIR FRENCH.

Our Bookshelf.

A Manual of Determinative Mineralogy. By Prof. J. Volney Lewis. Third, revised and enlarged edition. Pp. v+298. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 16*s*. 6*d*. net.

WE have here an excellent guide to the recognition of mineral species. It is not intended to supersede the use of a standard work on mineralogy, but to train

a student to acquire a first-hand knowledge of minerals and their distinguishing characters and ultimately a facility in identifying the commoner species at sight. There is a general classification occupying more than 130 octavo pages based on physical characters, especially streak, colour, and hardness, in the order named. After a rather full account of blow-pipe and other convenient chemical tests, including some which are not commonly employed in this country, there is another classificatory table of 70 pages constructed to assist in the identification of minerals by this means. This is followed by a third table based on the crystalline system and hardness. Perhaps greater stress might have been laid on specific gravity, the determination of which is frequently one of the most rapid means of "running down" a doubtful mineral. Also no mention is made of the use of a permanent horseshoe magnet with special adjustable poles by the help of which the comparatively weak magnetic character of minerals like monazite can be easily recognised even in the field. J. W. E.

(1) *Botany for Students of Medicine and Pharmacy.* By Prof. F. E. Fritch and Dr. E. J. Salisbury. Pp. xiv+357. (London: G. Bell and Sons, Ltd., 1921.) 10*s.* 6*d.* net.
(2) *Junior Botany.* By T. W. Woodhead. Pp. 210. (Oxford: Clarendon Press, 1922.) 3*s.* 6*d.* net.
(3) *The Elements of Vegetable Histology.* By Prof. C. W. Ballard. Pp. xiv+246. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 18*s.* net.

(1) Prof. Fritch and Dr. Salisbury have prepared an elementary text-book, which is stated in the preface to be for the use of students of medicine and pharmacy. A large number of new figures of plant structures are produced, and many of them will form a useful addition to botanical illustration. A few, however, such as Figs. 69 and 71, are too diagrammatic, sketchy, or ragged to be desirable for elementary students, and of course they are of no use for any other purpose. The book begins with the plant as a whole, using the Shepherd's-purse as type. It goes on with several chapters on the various plant organs and their functions. The chapter on plant cells concludes with an account of protoplasm in colloidal terms. Growing points, tissues, cell contents, and the structure of roots, stems, and leaves are then carefully treated, followed by physiology and the study of types. The book ends with a chapter on heredity and evolution, and an appendix dealing with reagents and methods. It covers adequately the syllabus for medical students and is one of the best we have seen for this purpose, but it is questionable if a somewhat more biological and scientifically imaginative treatment of the subject would not be to the advantage of elementary botanical teaching.

(2) The second volume under notice is a neatly produced little book of more elementary character, and well illustrated, the 140 figures being new with one exception. It begins with a chapter on the garden stock, followed by condensed treatment of seeds and germination, roots and their function, the shoot and its physiology, hibernation and movement in plants. The second part deals with the structure and biology of the flower, including pollination, fruits, dispersal, etc. Every beginning student would find it useful, particularly for its studies of flowers and fruits, and the price is very moderate.

(3) The only features we can recommend in Prof. Ballard's book are the paper and binding, and the first and the last chapters, dealing with the structure and use of the microscope and its accessories. The body of the work is too crude, even for the pharmacy students for which it is intended, to deserve the name of botany. A single quotation from p. 122 will be sufficient to indicate how many errors can be packed into one sentence. "Communication between the various cells forming a tracheid is effected by means of pores in the vessel walls." The illustrations can only be characterised as for the most part very poor. Fig. 29 is intended to illustrate mitosis, and is stated to be "modified" from Strasburger's text-book. The drawings are almost caricatures. They show centrosomes where none exist, and the name "polar bodies" is given to them! It is a disservice to botanical science to publish a book of this character. R. R. G.

The Autonomic Nervous System. By Prof. J. N. Langley. Part I. Pp. viii+80. (Cambridge: W. Heffer and Sons, Ltd., 1921.) 5*s.* net.

THE present small volume gives a very useful summary, clearly and concisely written, of the present position of our knowledge of the subject of which it treats. The author divides the peripheral nerves into somatic and autonomic, and the latter into sympathetic (thoracico-lumbar, to all regions of the body), enteric (plexuses of Auerbach and Meissner), and parasympathetic, which is again divided into tectal (or ocular, supplying the sphincter of the iris and the ciliary muscle), bulbar (alimentary canal from nose and mouth to large intestine, with appendages, including the lungs), and sacral (lower part of large intestine, bladder, and external genitals). The several chapters deal with the divisions of the autonomic system and nomenclature; the general plan of origin and of peripheral distribution; the nerve fibres of the autonomic system; the specific action of drugs on the sympathetic and parasympathetic systems; and the tissues innervated. Each chapter is followed by a bibliography of important papers and by a series of notes.

First Course in the Theory of Equations. By Prof. L. E. Dickson. Pp. vi+168. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 8*s.* 6*d.* net.

THE introduction to the Theory of Equations contained in this volume is wide enough to cover the needs of all except those who aspire to become mathematical specialists. The methods throughout are strictly elementary, the treatment reaching the algebraic solution of cubic and biquadratic equations without any reference to substitutions or group-theory. Useful chapters on determinants and elimination are included, while another one deals with elementary properties of symmetric functions. The book contains a severe course of computation within the scope of its subject-matter, and a considerable proportion of the abundant examples are numerical in character. Two subjects avoided by most writers of elementary

text-books are discussed in a satisfactory and convincing way: (1) the impossibility of trisecting an angle, and (2) the construction of a regular polygon of seventeen sides, by the methods of Euclidean geometry. Prof. Dickson's book possesses all the merits of an excellent text-book, and it is to be hoped that its circulation will be a wide one.

Department of Scientific and Industrial Research: Fuel Research Board. A Handbook on the Winning and the Utilisation of Peat. By A. Hausding. Translated from the Third German Edition by Prof. Hugh Ryan. Pp. xxiii + 506. (London: H.M. Stationery Office, 1921.) 30*s.* net.

AN account of some processes for the utilisation of peat, particularly as a fuel, with references to German patents is given in the volume under notice. The mechanical details are better dealt with than the chemistry, which is often ludicrously inaccurate. The translator, indeed, often remarks on the latter point, and on the inaccuracy of the calculations, but makes no attempt to put things right. Some of the illustrations (*e.g.* Figs. 16, 46—which seem to be repeated in 54, 68, 69, 71, etc.) are very poorly reproduced. In spite of obvious defects the book contains a large amount of practical information not otherwise available in English, and will be of value to those interested in peat utilisation. An appendix, giving a reasoned account of the complete failure of some recent schemes, would have been instructive. The statistical information should be compared with that contained in the Final Report of the Nitrogen Products Committee, which is probably more accurate.

The Petroleum Industry: A Brief Survey of the Technology of Petroleum based upon a Course of Lectures given by Members of the Institution of Petroleum Technologists on the occasion of the Petroleum Exhibition, Crystal Palace, 1920. Edited by A. E. Dunstan. Pp. vi + 346. (London: The Institution of Petroleum Technologists, 5 John Street, Adelphi, n.d.) 14*s.* 6*d.*

THE petroleum industry is of peculiar interest and importance to the British Empire, and all readers of NATURE will welcome the appearance of the present volume. The series of lectures by experts have been carefully co-ordinated, and the result is very readable. All phases of the industry, from the prospecting for oil to the various uses of the finished products, are treated in a way which is a model of lucidity combined with accuracy of detail, and the book cannot fail to be of interest both to the specialist and to the general reader. The illustrations are particularly good. In the opinion of Sir Frederick Black "oil is not likely to supplant coal, but should supplement it"—a wise counsel.

Town Gas Manufacture: A Practical Introductory Treatment of the Equipment and Processes of an Average Gas Works, for Students, Junior Gas Engineers, and others connected with Gas Works. By Ralph Staley. Pp. xii + 108. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.

THE scope of this book is sufficiently indicated by its title and sub-title. The accounts of the manufacture of gas coal and water gas, including purification, are brief but clear, and the illustrations are good. There is mention of "great pressure setting up heat" in stacks of coal (p. 6), and "high heats" (pp. 81-82), meaning high temperatures. The account of the reaction in the gas producer is out-of-date, while washing with anthracene oil might have been mentioned as a method of removing "naphthalene, that mysterious bugbear." The fact that carbon monoxide is dangerously poisonous is also worthy of mention to junior gas engineers. The book should be very interesting to students of chemistry as well as to those intending to enter gas works.

A First Book of Chemistry for Students in Junior Technical Schools. By Dr. A. Coulthard. Pp. viii + 156. (London: Sir I. Pitman and Sons, Ltd., 1922.) 4*s.* 6*d.* net.

DR. COULTHARD'S book has some features which distinguish it from the scores of "elementary" or "junior" text-books which have appeared in recent years. It is quite up-to-date in its information; the scope is limited but is still sufficient to give a good view of the fundamental laws of chemistry, although the atomic theory is not included, the book finishing with equivalents. In connection with class work and practical work (over a hundred good experiments are described) the book should be found useful, and it may be recommended for use in junior classes. Ten years ago a book of this size would have sold for two shillings at the outside, but the price is probably reasonable nowadays.

Manuel de parfumerie. Par I. Lazennec. (Bibliothèque Professionnelle.) Pp. 281. (Paris: J.-B. Baillière et Fils, 1922.) 8 francs.

M. RENÉ DHOMMÉE is editing an encyclopedia of 150 volumes on "travail national," which is intended for French artisans. The idea is good, and corresponds in many ways with that of the "Life and Work" Series now being published by Messrs. Macmillan. The scope of the book is similar to that of Parry's "Perfumes," recently noticed in NATURE, but is not quite so full on the scientific side. The technical processes are described in detail, with illustrations, and there are numerous recipes (which are not given by Parry). The book should fulfil its object, and we wish the editor success in his enterprise.

Oils, Fats, and Fuels. By T. Hull. Pp. viii + 143. (London: Blackie and Son, Ltd., 1921.) 3*s.* 6*d.* net.

A VERY elementary account of the subject suitable for students in technical schools and classes will be found in this book. The chemistry of the materials and processes are not dealt with, formulæ and equations being purposely omitted. There is no index. On p. 128 the composition of "modern coal gas" is given as containing only 8 per cent. of carbon monoxide and 3·5 of "oxygen, nitrogen, etc." This must refer to genuine coal gas and not to the "modern" variety. No mention of fat hardening is made.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Geology and the Nebular Theory.

THE literature of geology has grown so immense that no man can be familiar with all of it, particularly when it refers to another continent than one's own, yet it comes as a surprise to a Canadian to find eminent Old World geologists still referring to the nebular hypothesis as an established fact of geological history. A few weeks ago Prof. J. W. Gregory suggested that life began on mountains, since these were the first parts of the earth's crust to cool to a suitable temperature, and more recently Prof. Joly, in discussing the age of the earth, assumes the truth of the nebular hypothesis, though he admits that "there was indeed some scanty sedimentation in Archæan times."

Probably no country includes a larger area of Archæan rocks than Canada, and several parts of the area have been studied as carefully as possible because of their importance as mining regions, yet no evidence of a hot earth has been found. The Huronian rocks of cobalt include a glacial deposit which is known to have covered many thousands of square miles. The Sudbury or Timiskaming Series, next in age, consists almost entirely of sediments, such as boulder conglomerates which may be glacial, arkosi with unweathered feldspars, and graywacke with seasonal leanding. Near Sudbury the series has a thickness of more than 20,000 feet.

The oldest rocks of all are the Keewatin and the Grenville Series, the former consisting mainly of volcanics but including thousands of feet of sedimentary gneisses and of "iron formation"; the latter is made up wholly of sediments, reaching a thickness of more than 50,000 feet in places and containing immense deposits of limestone, as well as much carbon in the form of graphite.

It might be thought that the Keewatin lavas imply a hot condition of the earth, but as a fact most of them exhibit pillow structure, showing that they were poured out into water. Liquid water existed over many thousands of square miles, and probably the temperature was low enough for the life of algæ and perhaps of primitive animals, as suggested by the carbon and limestone. The rocks of this most ancient known geological period do not indicate a higher temperature than that of later times.

It is probable, however, that those geologists who think of the earth as hot in Archæan times have in mind the granites and gneisses which underlie the most ancient sediments, the Laurentian rocks of Canada and similar plutonic rocks of other countries, which undoubtedly are of eruptive origin, and have been described as part of the original crust of the molten earth. In reality the Laurentian batholiths are far younger than the sediments and volcanics of the Keewatin and Grenville which they have invaded, and a similar welling-up of plutonic batholiths has occurred at numerous times in the later history of the world, and is perhaps still taking place beneath great ranges of youthful mountains like the Andes and Himalayas.

The coast range of British Columbia, 1100 miles long and 100 broad, consists of just as characteristic batholithic rocks as the Laurentian, but is of Jurassic age, and the Andes, which are still younger, appear to be largely of the same character. Granite and gneiss may be of any age, and do not imply a cooling earth as some have supposed. We find greater areas of such plutonic rocks in the most ancient geological periods simply because they have been exposed to denudation for a longer time, and so have been more widely uncovered.

The conditions found in the Archæan of Canada are repeated in Brazil, India, and Scotland, and probably other countries of which the present writer has no personal knowledge. The oldest rocks in the world are sedimentary and indicate temperatures like those of later times. If the earth was ever a molten sphere, there is no evidence of this condition in the geological record, and geologists should not cling to an outworn theory which the astronomers themselves have largely given up. In the planetesimal theory a method of world building has been provided which permits of a cold surface from the beginning, and fits far better with the known geological facts than the nebular theory.

A. P. COLEMAN.

University of Toronto, Toronto, Canada, May 16.

Species and Adaptations.

MR. BATESON'S address to the American Association at Toronto last December, which was published in NATURE of April 29, exhibits features of the same kind as those which were evident in his address to the British Association in Australia in 1914. In the Australian address he maintained that the effect of the discoveries and investigations in recent years in the phenomena of heredity and variation was greatly to increase the difficulty of understanding the origin of any characters which were new in the proper sense of the word. He went so far as to suggest that all characters which have appeared in the course of evolution may have been present in the protoplasm or nuclear structure of the original unicellular forms from which later forms, including man, have descended, all apparently new characters having been due to loss of inhibiting factors and segregation of various simpler combinations from the original complex. Now Mr. Bateson again declares himself an agnostic with regard to the evolution of species, and in spite of all modern discoveries, or because of them, states that we are farther than ever from any satisfactory explanation of the evolution of a new species, or of two or more species, from a single ancestral species.

Mr. Bateson admits that plenty of Mendelian combinations would in nature be given specific rank, and then proceeds to state that the topic of evolution is now dropped in genetical circles. He then illustrates the rule of silence on this favourite subject of a former generation by devoting the rest of his discourse to it, only to lead up to the conclusion that specific difference probably "attaches" to a base of which we know absolutely nothing at all. Our faith in evolution, Mr. Bateson declares, is unshaken; our doubts are merely as to the origin of *species*.

Now I have no intention of stating in opposition to Mr. Bateson that our present knowledge fully explains the origin of new species; I wish merely to offer some criticisms of the difficulties which he describes. In the first place, I dislike the expression "faith in evolution." I do not share the distrust in facts and reasoning which is now in vogue as a reaction against the excessive confidence of the nineteenth century. Evolution is a question of science, of verifiable facts and sound reasoning, and has nothing to do with faith. Mr. Bateson himself in another paragraph

states that we have absolute certainty that new forms of life, new orders and new species, have arisen on the earth. The explanation is the difficulty, but we have ample evidence that organisms, whatever their characters, are only produced by reproduction from parents.

One is tempted to conclude that Mr. Bateson attaches some mystical meaning to the word "species." He says we have no reason to suppose that any accumulation of characters of the same order as those met with in genetical experiments would culminate in the production of distinct species. According to him there is some underlying base which is specifically distinct and bears the characters. I fail to see that this idea has any scientific meaning or validity. What is this base? In science we must regard things and phenomena objectively. We distinguish species by characters, just as we distinguish all objects by their qualities. For example, we have the familiar example of single comb and rose comb in fowls. We cannot have singleness and rose-ness without the comb that exhibits these characters. If they occurred in nature, excluding crossing or hybridisation, they would be specific characters, at least in company with other differences they might be. Is the comb then the base? The comb must have some character and shape, and thus we cannot have the comb without a character. We can have the entire absence of comb, as in the allied genus Phasianus; and so with all other characters. This idea of a specific base distinct from specific characters seems merely false metaphysics. How can we conceive of an organism without characters, or characters without an organism? Perhaps Mr. Bateson means that unit characters such as those which can be transferred in Mendelian crosses might all be taken away, and still an organism would be left with non-Mendelian characters. What are these characters? He does not tell us. We have cases of the absence of pigment in, *e.g.*, a bird, then the feathers are left. We may have an organism without feathers, and then the skin is left. We can scarcely have an organism, at any rate a vertebrate, without a skin. On the other hand, we may have factors, whatever their nature, which in the absence of one or more other factors produce no visible character, as in the cases of white varieties of animals and plants which, when bred together, produce coloured offspring. It has been shown that there are several kinds of white varieties or races, the distinguishing characters of which are invisible. Perhaps Mr. Bateson means that species were originally distinct in this way, separated by characters which were non-apparent.

Mr. Bateson insists on the rarity of the occurrence of new dominants under observation in experimental breeding, although new recessives, that is, the loss of particular characters from a combination, are common enough. Even in Drosophila few new dominants have been seen, and none of these could be expected to survive under natural conditions. He further states that in tracing the origin of our domesticated animals and plants we can scarcely ever point to a single wild species as the probable progenitor. Now it seems to me that there is very good evidence that all our breeds of domesticated fowls have descended from *Gallus bankiva*, and in the numerous existing breeds there are many dominant characters which are not present in the wild ancestral form, *e.g.* the dominant white of the White Leghorn, and the rose comb. Mr. Bateson says he cannot imagine such a new dominant character being produced. But surely it is evident that they have been produced in the succession of generations of domestic fowls. Mr. Bateson's difficulty seems to be merely that we do not know how they came into existence. We can, however, scientifically form the conclusion that they originate by some change or development in the chromosomes, not directly dependent on any corresponding external stimulus.

Another reason which Mr. Bateson gives for his scepticism is that the chief attribute of species is that the product of their crosses is frequently sterile. This seems on the face of it illogical. If the sterility is only frequent it follows that there are many cases in which such sterility is absent. In that case, as there are many species which produce fertile offspring, the sterility of species hybrids cannot be the "chief attribute" of species. It is neither a universal nor necessary characteristic, and all we can say is that we do not know how it arises in certain cases. John C. Phillips in America crossed three wild species of duck (*Anas boscas*, *A. tristis*, and *Dafila acuta*) and found the progeny fertile. Bonhote has published the results of numerous similar experiments in this country. The various species of Bovidae also are stated to be fertile *inter se*.

I find it very difficult to understand Mr. Bateson's reasoning on this subject. He states in one place that the fact that hybrids between species are by no means always sterile is a commonplace of everyday experience, and then a little farther on, insists that until the production is witnessed of an indubitably sterile hybrid from completely fertile parents which have arisen from a single common origin, we have no acceptable account of the origin of "species." The two statements contradict each other. Interspecific sterility may be very mysterious, but it has nothing to do with the origin of these species which do not exhibit this sterility. Moreover, there is evidence of the occurrence under observation and experiment of new varieties which are more or less infertile with one another. *Œnothera gigas*, a mutant from *O. Lamarckiana*, shows a great degree of sterility when crossed with other mutants from the same species, and two mutants of Drosophila in Morgan's experiments are almost completely sterile with one another.

It is not very surprising that genetical researches of the Mendelian kind have not thrown much light on the occurrence of variations and mutations, for except in the cases of Œnothera and Drosophila they have usually consisted in analysing by crossing experiments the hereditary factors already present, instead of breeding many generations from a single form and studying the variations that occur. To my own mind, there is no proof that the numerous breeds and varieties of domestic fowls, all descended almost certainly from the single species *Gallus bankiva*, differ in their essential nature from groups of closely allied species and varieties in a natural state.

The feeling, however, that chiefly prompts me to comment upon Mr. Bateson's Toronto address is one of protest against the implied disparagement of those who have not ceased to discuss evolution. There is more in evolution than the origin of species. Mr. Bateson himself has contributed largely to the proof that the distinctions between species have little or nothing to do with adaptation, but at the same time he has failed to realise the true nature and importance of adaptation in itself. In his address he makes no reference at all to adaptation, or to the relation which it bears to recapitulation in ontogeny, one of these "academic problems of morphology" which were discussed with such avidity when both he and I were young, and which he relegates with such confident assurance to the limbo of obsolete things. Yet he writes of the older time: "Regardless of the obvious consideration that 'modification by descent' must be a chemical process, and that of the principles governing that chemistry, science had neither hint nor surmise nor even an empirical observation of its working."

One would almost suppose that Mr. Bateson was a bio-chemist. But how much chemistry is there in the analysis of Mendelian factors, or the identification of spots in chromosomes which represent particular genes? The suggestions of the nature of the "chemical process" have come from the physiologists and from those who, without ignoring the methods and discoveries of genetics, have not ceased to discuss evolution and adaptation. It is true that some geneticists have discussed the question whether factors for colour might be chemical compounds reacting on each other, but they have not explained how chemical compounds such as enzymes and chromogens could be contained in separate chromosomes and segregate from each other in the reduction divisions of gametes. I do not remember any case in which "modification by descent," that is the loss or gain of a unit character, has been shown by geneticists to be due to any chemical process. The latest results of the American investigators concerning the localisation of genes in the chromosomes, concerning which Mr. Bateson states that all his scepticism has been removed, are purely morphological.

All the progress that has been made in our knowledge of unit characters and of specific characters has tended to exhibit more and more clearly the difference between such characters and adaptational features. It is seldom that an adaptation is confined to a single species, and it is impossible to perceive any connexion between mutations or unit characters and the relation of adaptations to function and external conditions. One great event in the evolution of both animals and plants was the adaptation of the descendants of aquatic forms to terrestrial and atmospheric conditions. In the case of animals, we have, in the metamorphosis of Amphibia and the embryonic development of higher vertebrates the recapitulation of this transition from aquatic organs of respiration to atmospheric organs, not by conversion but by substitution. It is certain from this evidence that the change was perfectly gradual and continuous, and parallel to the gradual change of conditions and mode of life. Recapitulation in this case, however ancient a subject it may be, is an obvious fact, and nothing that the geneticists have discovered throws any light on it, or diminishes its importance. It is no use dismissing it as early Victorian. The question is, have the recent, much vaunted discoveries explained it, or have they anything to do with it? Variations in wings, eye colour, etc., of flies bred in milk-bottles are important in their own sphere, but they throw no light on the annual growth, denudation, death, and recrescence of the antlers of a stag, or on the remarkable relation between these processes and the hormones from the gonads. The origin of species is a very important problem, but it is not the whole, or the most important part, of evolution. The origin of adaptations is not the same problem as the origin of species, and the methods of modern genetics have very little bearing upon it. Mr. Bateson's address suggests that he has not yet realised the difference between the two problems, or paid serious attention to modern physiological knowledge bearing on functional adaptation. The phenomena of recapitulation, so closely associated with adaptation, imply wherever they occur a continuity in the evolutionary change of which the adaptation was the result, and these phenomena are quite incompatible with the discontinuity which is characteristic of non-adaptive variations, and which is the cardinal principle of Mendelians and mutationists.

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Evolutionary Faith and Modern Doubts.

No one can have read without interest Dr. Bateson's admirable address on evolution published in NATURE of April 29. While Dr. Bateson's reputation is justly high and his views necessarily command respect, it must be admitted that some of his arguments are very difficult to follow. When, for example, he says that "the conclusion that species are a product of a summation of variations, ignored the chief attribute of species, that the product of their crosses is frequently sterile in greater or less degree," I am frankly puzzled. The proposition is certainly not self-evident. If a sword and its scabbard are bent in different directions, it will happen sooner or later that the sword cannot be inserted, and the result will be the same whether the bending be effected by a single blow, or whether it be, in Dr. Bateson's words, "a product of a summation of variations." Is this illustration inapt? The sword and its scabbard are the homologous chromosomes. These presumably have to co-operate to produce the somatic cell of the hybrid, and their co-operation might be expected to require a certain resemblance, but for the production of sexual cells they must do more, they must conjugate; and for conjugation it is surely reasonable to suppose that a much more intimate resemblance would be needed.

We might, therefore, expect, on purely theoretical grounds, that as species and genera gradually diverged, it would be increasingly difficult to breed a hybrid between them; but that, even while a hybrid could still be produced, a fertile hybrid would be difficult or impossible, since the cells of the germ-track would fail to surmount the meiotic reduction stage, when the homologous chromosomes conjugate. This is exactly what happens: the cells go to pieces in the meiotic phase.

It would even seem that the argument is exactly contrary to Dr. Bateson's statement of it: it seems easier to imagine sterility arising from a gradual modification, spread over a length of time, and involving many chromosomes, than from the half-monstrous variations chiefly studied by Dr. Bateson and his school, variations which appear to affect only a few chromomeres, and those by loss alone.

Now I certainly cannot pretend to much or special knowledge, either in genetics or cytology. But I would ask Dr. Bateson in all humility whether there is any difficulty involved in this simple solution of his problem. Very likely there is, but he does not indicate it.

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Transcription of Russian Names.

IN NATURE of May 20, p. 648, is published a letter from Maj.-Gen. Lord Gleichen, who raises objections to Prof. Brauner's suggestion (NATURE, April 29) that we should adopt the Czech transcriptions for the names of Russian men of science.

The argument that there are typographical difficulties is surely a very small one, since NATURE and other journals (*e.g.* that of the Chemical Society) already employ letters with diacritical marks in writing the names of Czech and other authors. Whilst diacritical marks are undesirable for place names on maps, the same need not apply to the names of persons.

The main points raised by Prof. Brauner in support of his suggestion, remain unchallenged, and in addition to these it may be mentioned that the Czech language is phonetic and Russian names can thus be accurately pronounced according to it.

Further, it may be confidently anticipated that the men of science and scientific institutions of the Czecho-Slovak republic will accomplish much in the way of scientific advancement in the future, and consequently will receive more adequate notice in British journals than has hitherto been the case (compare Prof. Brauner's own resumé of "Science in Bohemia" in NATURE, May 13).

Finally, many Russian authors now publish in Czech journals and consequently use the Czech transcriptions for their own names.

J. G. F. DRUCE.

May 24, 1922.

Immediate Solution of Dynamical Problems.

A DISCUSSION is submitted here in the manner called elementary, where the theorems of the gravitation of a sphere are proved for any portion of a spherical surface, such as a bowl, before proceeding to the result for a complete sphere (see letter by Prof. Andrew Gray in NATURE, May 20, p. 645).

Consider the potential (Fig. 1) at P, dU, and attrac-

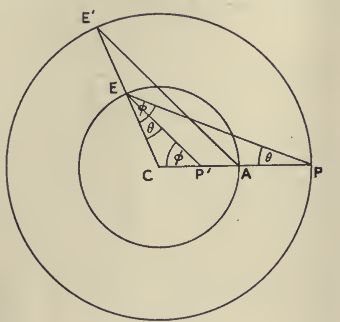

FIG. 1.

tion to the centre, dF, of a small element dS at E, of the surface of a sphere, centre C and radius $CA=c$, taken of superficial density σ, g/cm², with G the gravitation constant. Then

$\frac{dU}{G\sigma}=\frac{dS}{EP}$, with $EP=CE\cos\phi+CP\cos\theta$, so that, with $CP=r$, and P′ the inverse point to P in the sphere, $CP'=r'=\frac{c^2}{r}$, $\frac{dS}{EP}=\frac{dS}{EP^2}(CE\cos\phi+CP\cos\theta)$

$$=CE\frac{dS\cos\phi}{EP^2}+CP'\frac{dS\cos\theta}{EP'^2}\quad\left(\text{because}\quad\frac{CP}{CP'}=\frac{EP^2}{EP'^2}\right)$$

$$=CE\,d\omega+CP'd\omega'=c\,d\omega+r'd\omega'=c\,d\omega+\frac{c^2}{r}d\omega',$$

reckoning the solid angles $d\omega$, $d\omega'$ subtended by dS at P, P′ as positive when the aspect of the surface is the concave side.

Then by summation over any finite portion of the spherical surface,

$\frac{U}{G\sigma}=c\omega+r'\omega'$, not restricted to the spherical bowl result in Maxwell's "Electricity and Magnetism."

And for F, the radial component acting along PC of the attraction at P,

$$\frac{dF}{G\sigma}=\frac{dS\cos\theta}{EP^2}=\frac{CP'}{CP}\frac{dS\cos\theta}{EP'^2}=\frac{r'}{r}d\omega'=\frac{c^2}{r^2}d\omega',\ \frac{F}{G\sigma}=\frac{c^2}{r^2}\omega'.$$

These two or three lines of geometry can thus replace some pages of analysis in Maxwell's "Electricity and Magnetism."

For a complete sphere, and P inside, $\omega=4\pi$, $\omega'=0$, $\frac{U}{G\sigma}=4\pi c$, $F=0$, and P outside, $\omega=0$, $\omega'=4\pi$, $\frac{U}{G\sigma}=4\pi r'=\frac{4\pi c^2}{r}$, $\frac{F}{G\sigma}=\frac{4\pi c^2}{r^2}$; the well-known theorems for a complete spherical shell, and thence for a solid sphere, given first by Newton in the "Principia" (1, 41), and of pioneering interest in justifying his theory of gravitation for a body, like an apple, brought from the moon down to the surface of the earth.

A recent article by Florian Cajori, on Newton's discovery of Gravitation, in the *University of California Chronicle*, April 1922, is worth the attention of Prof. Andrew Gray, in its bearing on his own historical reflexions on the importance of the attraction of a sphere in Newton's theory of universal gravity.

The further theorem, that the mean potential over the sphere of any body M outside the sphere is equal to the potential of M at the centre, is obvious by transferring an element of M at P to the other end of the vector PE. Or if M is inside the sphere, the mean potential over the surface is M/c.

In hydrodynamical analogy, the flux across any surface fixed in an incompressible liquid is the equivalent of liquid supplied to the interior from outside, and so interpreting and justifying the theorem of Gauss, between the surface integral of normal force and the attracting body M, inside or outside.

In this way the precept of Poinsot can be followed, to examine the nature of things in themselves by direct vision, and not through a mist of equations and formulas.

G. GREENHILL.

1 Staple Inn, London, W.C.1, May 27.

Arabic Chemistry.

IN a manuscript in my possession of the "Rutbatu 'l-Ḥakīm" of Maslima ibn Muḥammad Abu 'l-Qāṣim al-Majrīṭī († 1004 A.D.) the author claims to have written the section on chemistry in the celebrated "Letters" of the Ikhwānu'ṣ-Ṣafā (Brethren of Purity), the well-known Encyclopædists of Islām in the tenth century A.D. I believe this fact to have been hitherto unknown, as it is not mentioned by Dieterici or Brockelmann nor by Shahrazūrī, all of whom give as the names of the authors of the "Letters" only the following five: Abū Sulaimān Muḥammad ibn Naṣr al-Bustī, Abu 'l-Ḥasan 'Alī ibn Hārūn az-Zinjānī, Abū Aḥmad an-Nahrajūrī, al-'Aufī and Zaid ibn Rifa'a.

Maslima al-Majrīṭī was an accomplished chemist, and his work the "Rutbatu 'l-Ḥakīm" was mentioned by Ibn Khaldūn in the "Prolegomena" to his history. Although much of the "Rutba" is, as Ibn Khaldūn observes, very enigmatical, yet there are certain passages in it of considerable historical interest to chemists. Two of these I give below.

1. "I took natural quivering mercury, free from impurity, and placed it in a glass vessel shaped like an egg. This I put inside another vessel like a cooking-pot and set the whole apparatus over an extremely gentle fire. The outer pot was then at such a temperature that I could bear my hand upon it. I heated the apparatus day and night for 40 days, after which I opened it. I found that the mercury (the original weight of which was ¼ lb.) had been completely converted into a red powder, soft to the touch, the weight remaining as it was originally."

2. [On the refinement of gold and silver.] "Silver alloyed with lead may be separated from the latter by placing it in a cupel made from bones (called the 'dog's head' or commonly the *kūraja*; it is a crucible made from burnt bones) and fusing it by means of a strong fire. The lead is removed and absorbed by the cupel and the fire makes manifest

the lighter portion of the alloy; the silver remains pure and free from base metal. Silver may be separated from copper in the cupel by continual addition of lead until it appears in a state of purity. . . . Gold may be purified from silver and copper in two ways. From copper alone it may be refined by the method used to purify silver from copper, namely, cupellation with addition of lead. If it is desired, sulphur may be added as well; this burns the copper and the gold remains pure. Gold may be refined from lead by the method used to refine silver from lead. The purification of gold from silver may be carried out in two ways, one by means of minerals and the other by means of salts. The former method is as follows: the gold alloyed with silver is beaten out into thin leaves and these are placed on a bed of a mixture of hæmatite and salt and covered with more of the same mixture followed by a layer of red clay. The whole is then heated in the oven known to men of science as the 'refining-furnace,' when the silver is absorbed by the earthy matter and the gold leaves are left pure, containing nothing but the most refined gold.

"This operation may also be carried out in a similar way by using alum and salt, or by means of baked clay. The clay is finely powdered and mixed with an equal amount of salt and the two well powdered again. The mixture is then spread in a layer on a layer of red clay. A gold leaf is then added, followed by another layer of the mixture of clay and salt, and so on until all the gold has been added. A covering layer of clay and sand is then placed on the top and the whole strongly heated, when the gold is purified and extracted from the silver. . . . This is the process known as <u>sh</u>ahīra [refinement] by the people of this art. Gold may also be separated from silver in the same way that it is separated from copper. The gold-silver alloy is mixed with a little copper and the mixture fused, with addition of red sulphur from time to time. The gold refines away from the silver and is left pure. The former method, however, is the more efficient.

"The silver which is removed from the gold in the process called <u>sh</u>ahīra may be recovered merely by the addition of mercury to the earthy residue. The mercury thickens and coagulates until it becomes like dough, and this is the sign [of the completion of the action]. When it has become like dough it is placed in a crucible over the fire and the mercury then volatilises away from the silver." E. J. HOLMYARD.

Clifton College, May 29, 1922.

The Notion of Asymmetry.

MODERN refinements in our ideas of atomic and molecular structure at once demand a more precise definition of what exactly is meant by molecular asymmetry. Whether this asymmetry be due to certain groupings around a particular atom, or to the structure of the molecule as a whole, such physical properties as optical activity or enantiomorphism must ultimately be shown to be definitely related to the electronic and nuclear arrangements in the molecule itself.

Langmuir has shown that substances with molecules possessing similar electronic environments closely resemble each other in many of their physical properties, and he calls this phenomenon isosterism, the substances themselves being denoted isosteres. In this brief discussion it will only be necessary to consider the application of this idea to the simplest case of stereoisomerism.

The molecule *Cabcd*, where *a*, *b*, *c*, *d*, are all different atoms or groups, is asymmetric. It exists in two stereoisomeric forms, one the mirror image of the other. The substance having this molecular structure may crystallise in two enantiomorphously related forms, and may rotate the plane of polarisation of light. Now let *d* be replaced by *c'*, where *c'* is an isostere of *c*. Such a molecule is now no longer asymmetric as regards the arrangement of its electrons, but is certainly asymmetric if we take into account the inner nuclei. If the rotation of the plane of polarisation of light is dependent entirely on electronic movements, such a substance may not be optically active, and it may not even crystallise in two forms. We have not sufficient data to decide this matter; but it is obvious that the application of this idea to the case of isotopic elements entering into combination might lead to some interesting investigations. We will only consider the substance $CH . SO_3H . Cl_{35} . Cl_{37}$, where Cl_{35} and Cl_{37} are the two principal isotopes of chlorine. This compound, like *Cabcc'*, is asymmetric as a whole, but so far as its electronic environment is concerned, the two stereo forms are identical.

Now this particular variety of di-chlor-methane-sulphonic acid must be formed to a certain extent in the ordinary preparation of the substance, and it would seem that its isolation could be effected, only if it *did* actually exist in two enantiomorphously related forms. From what has been said this seems rather unlikely, but still, an investigation in this direction would throw some light on the matter, one way or the other. THOMAS IREDALE.

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The Evolution of Plumage.

MAY I be allowed to refer to some of the statements in the article on the Evolution of Plumage published in NATURE of May 20, p. 662.

(1) The writer (H. F. G.) states that in the case of ducks and penguins "the difference between their nestling coat and the final dress is enormous." In my paper on "The Nestling Feathers of the Mallard," I point out that the tail-quill protoptiles consist of a calamus, containing cones, a shaft and a distinct after-shaft, and especially that the barbules at the tip of the shaft in having hook-like cilia are more specialised than in some of the true metaptile feathers of the adult; hence it follows that feathers of the first nestling coat, instead of being simpler, may be more complex than true feathers of the adult coat.

(2) It is stated that in the emus the differences between the nestling feathers (protoptiles) and the feathers of the second and later generations "are reduced to a question of mere size." As the figures in my paper clearly show, the aftershaft of the feathers of the first generation is represented by a few simple barbs, whereas the aftershaft in the following generations is as long and as complex as the shaft.

(3) Owls and petrels are said to "have as thick and fluffy and long-lasting mesoptile coats as any penguin." In the case of the tawny owl the mesoptile coat is poorly developed and (in specimens I reared) shed soon after growth is completed—perhaps, like Pycraft, the writer of the article regards the feathers forming the first coat of true feathers in the tawny owl as mesoptiles; the feather figured in "A History of Birds" (p. 270) is not a mesoptile but a true (metaptile) feather. In a young petrel I received last autumn from Dr. Eagle Clarke, the mesoptile coat consists of simple feathers less than half an inch in length—in penguins the mesoptiles are complex and sometimes reach a length of four inches.

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(1) Surely the coats differ, almost beyond recognition in penguins; even in ducks, in which the first dress does not consist only of tail-quills.

(2) The figures [diagrams] show clearly that the all-important fact has been missed, namely, that the so-called aftershaft or byfeather consists not only of a few simple barbs but also of a distinct shaft.

(3) Perhaps it will save matters if we read: Some owls and some petrels have as thick and fluffy and long-lasting mesoptile coats as some penguins, relatively of course. For example, if some nestling feathers of the shearwater measure 24 + 26 = 50 mm. in length, this does not prevent large penguins from wearing still longer and longer-lasting coats; nor is it incompatible with some small petrels having mesoptiles (they vary much according to position) less than half an inch in length.

Perhaps some genius, not too much hampered by facts, may still discover a "law," or equation by which the palæontological dates of various groups of birds can be deduced from the relative emanations of their successive nestling coats. H. F. G.

The Atomic Weight of Mercury from Different Sources.

THE successful accomplishment of separating the isotopes of mercury (NATURE, 106, 144, 1920; *Phil. Mag.* 43, 31, 1922) suggested an investigation to determine the extent to which samples of mercury from different sources might show the same atomic weight, *i.e.* the same density, which is to be expected only if the various minerals contain the isotopes in the same ratio.

Mercury obtained from the following minerals was investigated:—

	Mineral.		Geological Period.
1.	Cinnabar from	Almaden (Spain)	Silurian.
2.	,, ,,	Phalz (Germany)	Permian.
3.	,, ,,	Idria (Dalmatia)	Triassic.
4.	,, ,,	California (U.S.A.)	Cretaceous.
5.	,, ,,	Santafiora (Italy)	Eocene.
6.	,, ,,	Ras-el-Mah (Tunis)	Upper Eocene.
7.	,, ,,	Gölnicz (Hungary)	
8.	Calomel ,,	Terlingua (U.S.A.)	Lower Cretaceous.
9.	Mercury oxychloride,	Terlingua (U.S.A.)	Lower Cretaceous.
10.	Cinnabar, synthetic, unknown origin		

After reduction with iron and repeated distillation of the metal *in vacuo* the densities were measured by the method described in the previous communication. We found no difference in density exceeding the possible experimental error, which amounted to 2–6 in a million, corresponding to 0·0004–0·0012 in the atomic weight. Considering the very different geological and geographical origin of the mercury samples investigated we can conclude, with great probability, that the isotopic composition of mercury of terrestrial origin is the same.

The following numbers are the density data ($d_4{}^0$) found in the literature:—

13·5959 (Regnault, 1807).
13·5958 (G. de Metz, 1892).
13·5956 (Vincenti and Omodei, 1888).
13·5953 (Volkmann, 1881).
13·5938 (Marek, 1883).
13·5937 (Thiesen and Scheel, 1898).
13·5886 (Biot and Arago, 1816).

The considerable differences exhibited by several of these numbers do not exclude the possibility that mixtures of different isotopic composition were measured. From the above-mentioned investigation, however, we are justified in assuming the differences as most likely due to experimental errors.

J. N. BRÖNSTED.
G. HEVESY.

Physico-Chemical Laboratory of the Polytechnic High School, Copenhagen, May 12, 1922.

The English Ph.D.

SOME time ago I had the privilege of listening to addresses by the heads of two prominent English colleges on the provisions for the English Ph.D. Quite frankly it was stated that this degree is intended to satisfy students from the Dominions and the United States. It is manifestly unfair to give an American, for example, as a result of his study a degree, like M.A., which is of little or no value in his own land.

Two fundamental mistakes, however, have been made which endanger the value of the English Ph.D. Perhaps this can be made clear by considering the matter from a purely practical aspect. The American undergoes the expense of his work for the Ph.D. primarily because it helps him to a better post than he would otherwise get. If his degree does not help him to earn his living it has no more than a sentimental value. When applying for his post, his degree is weighed by the faculty and other authorities. It is *their* opinion that determines the character of the university work for the Ph.D.

These people require evidence that the candidate has received what *they* consider to be the best training. In the first place, his degree must be from a place where his subject is well taught. For a post in geology the degree from a university where geology is represented by a distinguished professor is a valid claim, whereas one from a university with a less able geologist is of lower value. The English universities must recognise that the value of their Ph.D. depends on the distinction of their teachers and not on their antiquity or fame.

The general intellectual training of the man is a second factor. His degree must mean that he is imbued by the spirit of scientific research derived through contact with the leading investigators. This implies immediately that for the particular departments which the university decides to develop the Ph.D. instruction, it must have professors of the first rank. A general all-round training, at least in the man's particular subject, is also demanded. This implies that the student must spend his time at different universities. The man who has worked in physiology under Sherrington, Bayliss, Starling, and Langley is a better-trained man than one who has spent his whole three years with only one of them. The English system, however, seems to deny or discourage the principle of migration. Unless something like the German system of free migration is developed the English degree can never have a value equal to the old German one.

It is not necessary to discuss certain other regulations; they will lapse by their own failure. For example, one university has proposed that the student shall choose his problem of investigation at the beginning of his three years and devote himself mainly to following it under the guidance of the professor. Such a process would turn out a narrow-minded monk, and not the all-sided man of science of wide views that is demanded. Most of the regulations proposed by the universities are aimed at keeping out unfitted students—quite proper but minor considerations. In none of the discussions that I have heard has there been any conception of the more important matter of providing for the proper development of the scientific investigator with the gift of presenting his results to the world. Yet this is just what the American universities demand from candidates for vacant posts. What these provisions must be I will not attempt to indicate. They can be discovered only by careful inquiry into the causes of the success of some universities and the stagnation of others. E. W. SCRIPTURE.

Identification of a Missing Element.

IN two recent communications to the Paris Academy of Sciences (*Comptes rendus*, May 22), by M. A. Dauvillier and Prof. G. Urbain respectively, very definite conclusions have been reached as to the identity of celtium with the missing element of number 72 on the Moseley classification. This discovery is of special interest to British workers, since Moseley's last work dealt with this particular problem. Prof. Urbain adds a statement on the unpublished work of Moseley on the X-ray spectra of his preparations of the rare earths. In his paper M. Dauvillier announces the discovery of certain lines in the L X-ray spectrum of celtium which show that its atomic number is 72. An improved De Broglie photographic spectrometer was used, and the oxides of lutecium and ytterbium in a preparation of Urbain's were attached to the anti-cathode. The tube was run at a potential of 40 k.v., and nearly complete L-spectra of lutecium and ytterbium were obtained. In addition three lines of thulium were found and two feeble lines which were identified as the α_1 and β_2 radiations of celtium. These lines ($\alpha_1 = 1{\cdot}5618$ Å ; $\beta_2 = 1{\cdot}3194$ Å) fall in the correct places for the element of atomic number 72, between the corresponding lines of lutecium and ytterbium. The β_1 and γ_1 lines of celtium which might have been expected are coincident with the β'_2 and γ_3 lines of lutecium. Reasons are given why these lines of celtium cannot be due to any impurities, such as other rare earths.

The following is a translation of Prof. Urbain's paper in the *Comptes rendus*:

THE ATOMIC NUMBERS OF YTTERBIUM, LUTECIUM, AND CELTIUM.

"The results of M. Dauvillier's examination of my preparations containing celtium have a theoretical importance obvious to all who have followed recent scientific developments with regard to the chemical elements and their atomic structure.

"It is now unquestionable that the element of atomic number 72 is actually celtium. The atomic weight of celtium must therefore lie between 175 (lutecium) and 181·5 (tantalum). Characterised by two sets of spectral lines (arc and X-ray) and by the order of magnitude of its atomic weight, celtium has conclusively won its place among the chemical elements.

"Thus the problem of the constituent elements of Marignac's 'ytterbium' has been solved. The method of X-ray analysis is the most significant, and probably the crucial, test of a chemical element, and this method has confirmed the work I have done over a period of more than ten years on 'ytterbium,' using more difficult and probably less conclusive methods. Though I only succeeded in obtaining a partial separation, this was sufficient to permit the high-frequency spectra method to assign its atomic number to each of the constituents I discovered, namely, (neo-) ytterbium 70, lutecium 71, celtium 72.

"Now that these results are clear, I wish to outline a part of the history of these elements that has not yet become known to the scientific public. When I originally announced the discovery of celtium, Moseley's law of the atomic numbers was still unknown. After this law had been found it seemed evident that it should be possible to define the three elements of the ytterbium group by their X-ray spectra. Moseley himself put forward the hypothesis that celtium and the element with atomic number 72 were one and the same. On the other hand, Moseley, relying on the evidence of Auer von Welsbach, in his first lists of the elements had included two thuliums, while my experiments only permitted the existence of one.

"In order to settle this question, in June 1914 Ramsay and I visited Prof. Townsend's laboratory at Oxford, where Moseley was working. Our intention was to examine the different products of my separation of ytterbium by this young investigator's method, then unique.

"We found one thulium of atomic number 69, one ytterbium of atomic number 70, and one lutecium of atomic number 71. The spectra which Moseley obtained included only a few lines, and we could not find any corresponding to the element of atomic number 72. The first of these results was announced several years ago, but as the result of the researches of others. No claim of priority was possible, since Moseley himself was responsible for the publication of these results, and for this purpose had kept the necessary documents. But the war broke out before he had time to write his paper. He was among the first to enlist, and by great misfortune was killed at the Dardanelles.

"Sir Ernest Rutherford, who prepared the obituary notice of his pupil, wrote to me about these last researches of Moseley's, at which I had assisted. In the absence of precise data I thought I must forgo the publication of results that would rest on my memory alone.

"M. Dauvillier's discoveries complete the early results obtained at Oxford. They show that the negative result given by Moseley's method in the case of celtium was due only to the insensitiveness of the method, since the preparation examined by M. Dauvillier is the same as that used in Moseley's own X-ray tube."

Now that the missing element of number 72 has been identified, there remain only three vacant places of ordinal numbers—43, 61, 75—between hydrogen and bismuth in the Moseley classification of the elements. With the rapidly increasing perfection of technique of X-ray spectra and the use of powerful installations, it is to be anticipated that the missing elements should soon be identified if they exist in the earth. The law of the X-ray spectra, as found by Moseley, is an infallible guide in fixing the number of an element, even if present in only small proportion in the material under examination.

E. RUTHERFORD.

Recent Excavations at Stonehenge.[1]

By Col. WILLIAM HAWLEY, F.S.A.

THE arrangement of the stones at Stonehenge includes on the outside a circle of sarsen stones, which were originally thirty in number and were capped with lintels, forming a continuous ring round the top. Inside this circle is another of smaller stones, originally forty-three in number, but without lintels and of a different rock from those of the outer circle.

Within the second circle of small stones were five

[1] Address to members of the Portsmouth Literary and Philosophical Society on the occasion of a visit to Stonehenge on May 6, 1922.

trilithons of large blocks of sarsen. Two only remain standing and one stone of the third. They have lintels, but the lintels were not continuous and merely formed a cap to the two upright stones.

The trilithons are not arranged in a circle but take the form of a crescent or horse-shoe, as also do a series of fifteen small stones within them, similar to the others in the second circle. The smaller stones (or foreign stones) are from metamorphic rocks and have been brought from a long distance, but how or when has not yet been determined. Dr. Thomas of the Geological Survey considers the source of two kinds to have been the Prescelly Mountains in Pembrokeshire, where he found identical specimens. He considered that their deposition here by glacial action to be contrary to sound geological reasoning, and that their assemblage here pointed to human selection and conveyance. One sort is a porphyritic diabase, another is a rhyolite, both of which are extremely hard. Another sort is an argyllite resembling hard slate, but being perishable, no standing stone remains, though many pieces are found in the soil below the surface. All these stones appear to have been brought in a rough state and in naturally long slabs, which were afterwards dressed.

The sarsens had less far to travel, and there can be little doubt that they were brought from the Marlborough Downs, where there are still many boulders of them strewn over the land.

These big blocks or boulders are composed of siliceous granules, and were formed in the Bagshot sand of the middle Eocene, and were left behind when the sand around them was denuded in a geological change.

Before being conveyed here they were roughly squared by cleavage to lighten them, and after arriving they were neatly dressed, partly by picking with pointed flint tools and partly by crushing and grinding with mauls made of a very hard quartzite.

After standing here for about 4000 years they have naturally become greatly weathered, some more than others, depending upon where softer patches in their substance occur, so that it is only on the durable parts that tooling marks can be seen, but these are very clear where the surface has not been exposed, where the stones are protected below ground, and where the lintels fit upon the uprights.

For many years several of the stones were leaning dangerously and had to be propped, notably the four on the north-east and two on the east, all bearing lintels. H.M. Office of Works has had these stones set upright, and their bases are now firmly fixed in beds of concrete.

In this operation it was necessary to take down the lintels, and we were much impressed by the elaborate care that had been bestowed upon fitting them to the tops of the stones. Every lintel has two cup-shaped holes, which fit upon tenons projecting from the upright stones, so that each lintel has two holes and each upright has two tenons (except the trilithons which only require one tenon on each upright).

The fitting of the lintels to the tops of the stones had been done with such accuracy as to leave little doubt that they had been worked in unison and the lintel frequently tried on until a perfect fit had been accomplished. The same care was observable in the fitting of the ends of the lintels, as each one has a projection which fits into a recess in the next following it, locking them all together, and all this must have been done when the stones were upright and to ensure evenness of the tops all the way round.

These stones were irregular in their depth below the surface, the longest having 8 feet and the shortest 4 feet 6 inches below ground. The bases end in a blunt point, to facilitate movement when getting them into position. Most of them seem to have been brought to their places down an inclined plane cut in the solid chalk, but two cases were met with where they had been put in vertically. The pieces broken off the bases when pointing them were used for propping them whilst adjusting their position and before the soil was returned to the hole around the stone. A great many other pieces of stone had to be used, and these had to be sought at places a few miles from Stonehenge, as there is no stone in this neighbourhood. Wooden posts were used for a similar purpose, their holes being found below the stones and sunk about two feet in the chalk. The acquired stone was of two sorts, a glauconite and a ragstone, the former from Hurdcote near Wilton and the latter from Chilmark, a few miles farther west. The same quarries appear to have been used ever since, as similar stone is frequently met with in the British villages of the Roman Period, and we found that they had supplied all the stone for the building of Old Sarum. In this case a freestone had been used and not the rough slabs found here. The freestone occurs at a lower level, and is extensively quarried at the present day.

Finds of interesting objects have been remarkably few; indeed nothing of any special interest. The things found consist chiefly of rough flints used for dressing the stone and stone mauls, or hammer stones, of various sizes up to 43 lbs. in weight. Immense quantities of chips were knocked off by the masons. Those of sarsen occur at all depths, but those of foreign stone not lower than 30 inches, as they were put in last of all, and the building was probably a long, continuous work. The rubble below the surface, besides containing chips, yielded a few pieces of Bronze Age pottery, very small and foot-worn. The firm rubble had arrested the descent of these and also of small pieces of Roman Period pottery, and very occasionally a coin of that time. These were mixed with other things that had reached the rubble at every succeeding age down to the present time.

It is remarkable that the great number of people employed upon the construction of the place have left nothing behind them, for life in the Stone Age was not incompatible with a fairly high state of culture, as has been noticed in many instances. There was pottery of excellent design at the Temple of Tel Harkien at Malta, of Neolithic times, some of it being beautifully inlaid.

The use of this place has not yet been determined. Among ancient races religious and secular matters were intimately mixed, but this place could not have been for secular use, as apparently it was not inhabited. There are perhaps as many theories about Stonehenge as the stones which compose it, yet nothing is known with certainty about the nature of the place. It is trusted, however, that when the present research is finished some definite conclusion may be arrived at.

The place has been surrounded by a circular

earthwork and outer ditch. Also, within the earthwork there are round patches of chalk. These have been placed there to mark the sites of holes which were discovered two years ago. We have named them Aubrey holes after an investigator of that name who, in 1666, hinted at their possible existence, but did not find them. Only about half the number has been opened, but we have ascertained that there are fifty-six. They are evenly spaced at 16 feet apart, and there can be little doubt that they once held stones forming a continuous circle, older than the existing monument. The old circle stones would have been rough, undressed ones, and perhaps of about the date of Avebury. When the present monument was built it is possible that the rough stones were taken out and dressed and erected as the smaller stones now visible, as it is not likely they would have been wasted, and, moreover, their number corresponds nearly with that of the holes.

The empty holes appear to have been used for human interments, as nearly all of them contained cremated bones. Only a portion of the cremated remains of a body are found in each hole and in one instance only fourteen pieces of charred bone. The actual cremations must have been carried out elsewhere and the remains brought here for interment, for up to the present time no sign of a large fire has been met with; and the burning of only one body would require several tons of wood to calcine it thoroughly, and the quantity of black wood ashes remaining, being indestructible, would have been noticed. These interments occurred in Neolithic times, as chips were found amongst the debris in the holes, and in one instance an implement maker had thrown all his discarded chips into a hole.

Lately I have been excavating the ditch outside the earthwork. It was probably the first work done here, and from it I trust to get a continuous linking up of periods from the earliest to the latest. So far this work has not been very profitable, but has given a good result in showing that a very long time must have elapsed between making the ditch and rampart and the building of Stonehenge. It seems to have fallen into neglect, and was nearly silted up when Stonehenge was built. This is conclusively shown by finding the masons' chips only 14 or 15 inches below the surface in the rubble covering the silt, where they cease abruptly, the silt containing no trace of anything relating to Stonehenge. It is devoid of any objects beyond occasional small fragments of animal bone, but when the bottom is reached at 4½ to 5½ feet below the surface, flint chips discarded by implement makers are found in great quantities, but rarely an actual implement. Many staghorn picks used in the excavation of the ditch are met with, and the upper parts of antlers cut off and thrown away when the picks were made.

This season I am again excavating the ditch, and this time on the north-east, to find out if it was a continuous circle or whether the avenue was made at that time or later, when Stonehenge was built, for I am inclined to think that there were two distinct periods here—an early one, when the circle of stones stood round the rampart, and a later one when this Stonehenge was built, with a considerable interval between them.

The Sense of Smell in Birds: a Debated Question.

ORGANS of smell are present in birds as a class and are well developed in many species, but much doubt attaches to the nature and extent of their usefulness. The South American vultures and the petrels are noteworthy for the size of their olfactory chambers, and the Apteryx possesses a complicated nasal labyrinth and is peculiar in having its nostrils at the extreme tip of the beak. Yet even in cases like these the practical demonstration of a sense of smell is beset with difficulties, and the existing evidence is conflicting and largely inconclusive. It seems difficult, of course, to believe that the apparatus serves no purpose, especially where it is highly developed or is specialised along particular lines, but apart from the unsatisfactory quality of *a priori* arguments the alternative must be borne in mind that the organs may have some other function than a sense of smell of the kind with which we are subjectively familiar.

The sense of smell is notoriously acute in the majority of mammals. Although they are generally also well endowed with sight and hearing, it is by smell that they chiefly find their food and by smell that they receive the first warning of the proximity of enemies: the importance of approaching four-footed game upwind is a commonplace. In birds the case is obviously very different, for with them vision must certainly be given pride of place. Hearing, too, is very well developed in birds, and there is also often a delicate sense of touch—witness the bill of the snipe—and possibly some power of discriminating food by taste. It may be argued that a sense of smell would be less useful to birds than to mammals: the great distances from which some birds detect their prey seem practically prohibitive for any sense but vision, and the spaces of the upper air must form a much less favourable medium for scent than the ground winds on which mammals so greatly rely.

Like so many other problems of natural history, this question attracted the attention of Charles Darwin, and in "A Naturalist's Voyage Round the World" we read of the experiment which he made in a garden in Chile where twenty or thirty captured condors were tethered in a long row at the bottom of a wall. "Having folded up a piece of meat in white paper," he says, "I walked backwards and forwards, carrying it in my hand at a distance of about three yards from them, but no notice whatever was taken. I then threw it on the ground, within one yard of an old male bird; he looked at it for a moment with attention, but then regarded it no more. With a stick I pushed it closer and closer, until at last he touched it with his beak; the paper was instantly torn off with fury; at the same moment, every bird in the long row began struggling and flapping its wings. Under the same circumstances it would have been quite impossible to have deceived a dog." In the same place Darwin

refers to the well-authenticated experiments of a Mr. Bachmann with the American turkey-buzzard, another carrion-eating vulture and one in which highly developed olfactory nerves had been demonstrated by Owen. Portions of highly offensive offal were wrapped in thin canvas: the birds seemed unable to detect the food even when eating pieces of meat which were in some cases strewn on the outside of the package, but as soon as a small rent was made for them in the canvas the prize was at once discovered.

Both before and since Darwin's day the question of the absence or presence of acute smelling powers in birds has been much discussed, and the negative view has been maintained by many ornithologists of repute. To this question Mr. J. H. Gurney now makes a welcome and interesting contribution in a recent paper "On the Sense of Smell Possessed by Birds" (*Ibis*, 1922, Eleventh Series, iv, 225). After recounting the history of the discussion and making reference to the anatomical facts and experimental findings, he deals at length with the observational evidence in favour of the existence of an acute sense of smell in certain species. Among these the rook and some woodpeckers are cited on account of the accuracy with which they seem able to locate hidden grubs, below the ground in one case and beneath the tree-bark in the other. Various petrels are also mentioned, some of these being credited by good observers with the power, for instance, of detecting offal thrown overboard by fishing boats even in thick mist. Geese and ducks, too, have very frequently been thought to possess powers of smell, and in the Norfolk duck-decoys the watching decoyman customarily burns peat or the like to prevent the birds scenting him down-wind. Other birds, notably the great bustard, commonly forsake their nests if their eggs have been handled. The most striking case, however, is that of the vultures of different kinds which are familiar in many parts of the world. It is indeed difficult to explain on any other theory than that of scent how these birds of ill-omen should know when a death has occurred in a house, congregating on the roof as if in the hope of gaining access to the corpse which they cannot possibly have seen: the same faculty was traditional in this country as regards the raven, when that species was commoner than it is now. Against all this, however, there is a mass of testimony from naturalists and sportsmen that birds show little or no power of detecting the presence of an enemy, even if approaching down-wind, until either sight or hearing comes into play. The success with which bird photographers can conceal themselves close to birds' nests, for instance, is in marked contrast to the difficulty experienced in studying wild mammals. In the case of vultures, in particular, there is also the evidence of the experiments already quoted, and the experience of sportsmen in India that killed game is safe from these birds if left covered from view.

In view of the weakness of the evidence obtainable by direct observation, due to the difficulty of eliminating the possible action of the other senses under ordinary conditions, one would naturally look with hope to experimental methods. These, however, have not been altogether neglected, and the results have been disappointingly inconclusive. Bachmann's experiment, already quoted from Darwin, seems to be one of the best on record. Another essay was Dr. Alexander Hill's experiment (Nature, February 2, 1905) with domestic Turkeys, to which he offered alternative dishes of the same food, one untainted and the other containing some such substance as asafœtida, essence of anise, or oil of lavender. The results were very unsatisfactory, the birds appearing to be indifferent not only to the smell but also to the taste of the noxious substances. In America, Dr. R. M. Strong has tried the effect of placing hidden food close to doves confined in boxes which could be regulated to admit or to exclude odouis. Here again the results were negative, no notice being taken of the food by any of the birds. To these may perhaps be added the experiment carried out by Prof. Watson and Dr. Lashley on the noddy and sooty terns of the Tortugas Islands off the coast of Florida. These investigators were studying the homing faculties of breeding terns, and in some cases they tried the effect of sealing up the birds' nasal chambers with wax: here again no difference in behaviour was observable. This last experiment is of special interest because it had for its object the testing of the theory that the olfactory apparatus may function not as an organ of smell but as a mechanism for detecting the temperature or humidity of the wind and thus as an aid to directional guidance during prolonged flight.

There is, then, a well-developed olfactory apparatus in birds which one is reluctant to consider altogether ineffective, and there are instances of behaviour which are difficult to explain except on the supposition that an acute sense of smell exists in the species concerned. On the other hand, there is a greater mass of evidence of behaviour suggesting that the sense is not developed to any important extent, and the results of experiments—so far as they can be considered satisfactory at all—point in the same direction. It accordingly remains difficult to arrive at any definite judgment on the question, and scepticism as to the existence of any very efficient sense of smell in birds is probably still warranted. As Mr. Gurney says, the *onus probandi* rests with the upholders of the scenting theory.

The Hull Meeting of the British Association.

It is ninety-one years since the British Association for the Advancement of Science was founded, in Yorkshire, and it is sixty-nine years since the Association paid its single visit to Kingston-on-Hull. One prominent Hull citizen, the head of an important industry, who was present at the Hull meeting *as a member* is still living, but it is not anticipated that many others will remember the previous Hull meeting.

By the appointment of a strong executive committee and numerous sub-committees the arrangements for the Hull meeting are well in hand, and it is hoped that the attendance at Hull may exceed that at Edinburgh; everything possible is being done to attain that object.

Situated on the broad estuary of the Humber, at the junction of the river Hull, King Edward I., so long ago as 1299, saw the geographical advantages of the

town, and acquired the site from the monks of Meaux, from which date it became Kingston-on-Hull, and he gave a charter granting a fair (which is still held) and other privileges, which are yet preserved. Formerly a walled town, it played an important part in the Civil War in 1642, and still retains a number of buildings prior to that date which exhibit architectural features of interest.

To-day the city has nearly 300,000 inhabitants, many of whom obtain their livelihood from the fishing, shipping, and ship-building industries, and from the great works and mills connected with the production of oil, cattle food, flour, cement, black lead and blue, tar, paints, etc. There are also important fruit and wool markets, and many acres of timber yards. Enormous docks extending for miles accommodate shipping from all parts of the world, and in connexion with them are great warehouses and important railway and canal communications. In recent years, the King George Dock, one of the most up-to-date in the country, has been opened, a fine river-side quay has been erected, and there are elaborate appliances for the prompt handling of coal and for the storage of mineral oil. All this means that there is much of interest in the city to scientific workers.

Situated at the foot of the Yorkshire Wolds, Hull enjoys the position of being surrounded by a thinly populated area and has no other large town within many miles. It has special rail facilities for access to Scarborough, Filey, Flamborough, and other charming parts of the Yorkshire coastline, second to none in the country for variety of scenery and grandeur of cliff. Similarly the fine cathedrals and churches at York, Beverley, Selby, Patrington, Bridlington, Howden, and Hedon, well known throughout the country for their architectural charms, can easily be approached.

The plain of Holderness, with its cliffs of glacial sands and clays, provide problems for the glacial geologists, and rarely does it happen that so extensive and varied sections are available for study. The chalk wolds form a prominent feature, and quite apart from their geological and artistic attractions, were formerly thickly peopled by Briton, Roman, Saxon, and Dane, whose earthworks, burial mounds, and other remains still form attractive features in the landscape. During half a century the late J. R. Mortimer excavated most of these sites, and gathered together the contents of more than 350 burial mounds in his museum at Driffield, which has since been purchased for the Hull Corporation.

The Humber area itself has many problems of interest to the engineer, botanist, geologist, zoologist, and antiquary; while Spurn Point, with its questions of the sites of the lost towns of the Humber and of the coast, is of more than ordinary general interest.

During the Hull meeting special trains and other facilities will enable members to visit the various and numerous attractions in the East Riding and in North Lincolnshire; and already arrangements have been made for visits to be paid to places likely to interest the members.

In Hull itself, besides the fine old buildings already referred to, there is the Holy Trinity Church, one of the largest parish churches in the country, and certainly one of the oldest brick buildings still extant. In recent years the town has been entirely re-planned and largely rebuilt, fine wide thoroughfares having been cut through slum property, and these are lined with magnificent shops and public buildings. Of special interest to the visitors will be the old Trinity House and its Museum in Trinity House Lane; the birthplace of William Wilberforce, an Elizabethan mansion in High Street, now Hull's Historical Museum; the Museum of Natural History and Archæology at the Royal Institution, Albion Street; the Museum of Fisheries and Shipping at the Pickering Park; the Art Gallery in the City Hall; the Central Public Library in Albion Street, the Art School, and Technical Schools, and the old Grammar School (dated 1584) in the market place, all of which will be available to the visitors.

The city, being built on alluvium, is remarkably flat; its many miles of roads are excellently paved with wood blocks or asphalt, which, with the wide streets and fine buildings, give an appearance of cleanliness which is the envy of many larger cities. Hull is the only city in the country with its own telephones; its water supply is of the best, being drawn from chalk; and through the generosity of various benefactors and municipal enterprise, the city is well provided with public parks.

The various large engineering and manufacturing firms in Hull and district are taking keen interest in the meeting, and invitations to visit their works have been received. The Yorkshire Literary and Philosophical Society, at York, is issuing invitations for the members to visit its museum and grounds, and will provide afternoon tea, while the Lord Mayor of York will give a special welcome and has invited the members to visit the Guildhall and Mansion House. Hearty invitations have also been received from the Mayors of Scarborough, Bridlington, and Beverley to visit their respective towns, and each is doing his best to enable members to view the town's attractions, and refreshments will, in each case, be provided. The North Eastern Railway Company is taking exceptional pains to provide special trains, reduced railway fares, and late train facilities, in order to give the members every possible opportunity of visiting different places in East Yorkshire.

The local programme is a particularly attractive one, and the various lectures and addresses have an important bearing upon the district. For his presidential address Sir Charles Sherrington will take as his subject "Some Aspects of Animal Mechanism."

During the week the addresses of the sectional presidents will be delivered as under: "The Theory of Numbers," Prof. G. H. Hardy; "Research Problems in the Sugar Group," Principal J. C. Irvine; "The Physical Geography of the Coal Swamps," Prof. P. F. Kendall; "The Progression of Life in the Sea," Dr. E. J. Allen; "Human Geography: First Principles and Some Applications," Dr. Marion Newbigin; "Equal Pay to Men and Women for Equal Work," Prof. F. Y. Edgeworth; "Railway Problems in Australia," Prof. T. Hudson Beare; "The Study of Man," Mr. H. J. E. Peake; "The Efficiency of Man and the Factors which Influence," Prof. E. P. Cathcart; "The Transport of Organic Substances in Plants," Prof. H. H. Dixon; "The Proper Position of the Landowner in Relation

to the Agricultural Industry," Right Hon. Lord Bledisloe; "Educational and School Science," Sir Richard A. Gregory. The lamented death of Dr. W. H. R. Rivers deprives the psychology section of its president-designate. He had chosen as the subject of his address "The Herd-instinct and Human Society."

Among the subjects of joint discussions are: "Economic Periodicity," "The Origin of Magnetism," "Psychoanalysis and the School," "Mental Characters and Race," "The Present Position of Darwinism," "Vitamins," "The Possibility of increasing the Food Supply of Great Britain," and "Reformed Mathematical Teaching."

There will also be evening discourses on "The Atoms of Matter," by Dr. F. W. Aston, and "Fishing: Old Ways and New," by Prof. W. Garstang.

Special efforts are being made by the local secretaries at the Guildhall, Hull, to secure a large list of members, as by so doing it is hoped substantial grants may be made to the Association towards the advancement of science in its various ramifications. T. S.

Obituary.

Dr. W. H. R. Rivers, F.R.S.

Dr. William Hale Rivers Rivers, whose death occurred on June 4 at the age of fifty-eight years, came to Cambridge, at the invitation of Sir Michael Foster, in October 1893, to lecture on the psychology of the senses, and was made University lecturer in physiological and experimental psychology in December 1897; these two subjects were separated in 1907, when Rivers was made lecturer in the physiology of the senses. By this time he had established the Cambridge School of Experimental Psychology, which has produced many distinguished psychologists.

In 1898 Rivers joined the Cambridge Anthropological Expedition to Torres Straits and had charge of the psychological work, in which he was ably helped by his pupils, C. S. Myers and William McDougall. This was the first occasion on which trained psychologists with adequate equipment had attempted to investigate the psychology of natives in the field, and valuable results were obtained. While studying the psychology of the Torres Straits Islanders, Rivers began to collect genealogies in order to ascertain how far aptitudes or disaptitudes ran in families. He very soon found that the genealogies revealed a number of valuable data with regard to vital statistics, such as the number of births and deaths in a generation, the proportion of the sexes, the effects of fresh strains coming into a family, and the like. This method of research enabled him to record kinship terms with accuracy, and a consideration of them led to a study of social organisation. He also found that certain social duties and privileges were confined to certain specific relationships. Thus step by step he was led to realise the prime importance of social grouping for an understanding of social structure and function, and he found that the genealogical method was best fitted to supply the necessary data. On joining the Expedition, Rivers went out with the sole object of studying comparative psychology; he came back a keen ethnologist, having in the meantime forged a new instrument of research.

Four years later, in 1902, he went to south India to investigate the Todas, and in his important monograph ("The Todas," 1906) on that small but most interesting people, he proved once more the value of the genealogical method. His researches demonstrated how a trained mind, sympathetic manner, and scientific method can accomplish a great deal of first-class work in a relatively short time.

His first expedition to Melanesia was made in 1908, when he devoted most of his time to the Solomon Islanders. The practical result of his work there was the publication in 1914 of his monumental "History of Melanesian Society." The Melanesians were usually regarded as primitive folk of low culture, but Rivers demonstrated the existence of at least four layers of culture, due to as many migrations into that area. He dissected out, as it were, the main constituents of each layer, and showed that certain beliefs, rites, customs, and objects were found to be linked together in an organic whole in each layer or complex. He also discussed acutely the probable effects of one culture upon another, and showed that certain conditions which had usually been considered as due to social evolution were better regarded as a case of social adjustment between a pre-existing and an immigrant custom. The method formulated by Rivers is one of prime importance and is capable of indefinite extension to other peoples.

As an example of the continual growth of the mind of Rivers and his intellectual honesty, it is interesting to note that in his presidential address to Section H of the British Association in 1911, and in his "History of Melanesian Society" (1914), he points out the change that had taken place in his standpoint. The greater part of the book had been written as an evolutionist, and, in common with other English ethnologists, he believed that similarities of custom and belief are the results of the uniform reaction of the human mind to similar conditions. A further consideration of the facts and problems with which he was then occupied led him to the view that these similarities are the result of diffusion from a common source by means of migration—a view which certain older British ethnologists had held, though it was temporarily neglected. This change of standpoint prepared Rivers for an enthusiastic acceptance of the main principles enunciated by Prof. G. Elliot Smith in his "Migrations of Early Culture" (1915), and ever after Rivers was a keen supporter of cultural migrations.

Throughout this time Rivers continued teaching in the School of Psychology, and maintained his interest in that subject. He also made researches on the influence of alcohol and other drugs on fatigue, and on cutaneous sensibility in collaboration with Dr. Henry Head.

During the period of the war, Rivers was made temporary captain in the R.A.M.C., and naturally occupied himself with psychopathology. He was appointed Medical Officer to the Military Hospital, Maghull, later to the Craiglockhart War Hospital, and finally was psychologist at the Central Hospital R.A.F.

His wide knowledge, not only of psychology but of human nature, gained by investigation of various types of natives, his interest in the minds of all with whom he came in contact, together with a broad sympathy and charming manner, rendered him peculiarly fitted for this delicate and highly important work. His success was very great, and he kept in touch with as many of his old patients as was possible, and as their letters prove, they regarded him with intense gratitude and affection. The experience thus gained enabled him to produce his later important works, such as "Instinct and the Unconscious," and his lectures and papers on dreams. He accepted many of Freud's conclusions, but carried them to a very different issue in the light of his own observations during his military service.

From the foregoing it is evident that the mind and sympathies of Rivers were not only continually becoming more intensive, but were simultaneously broadening; he regarded all human conditions as the appropriate study of psychology and ethnology. This is illustrated by his last phase, when friends in London, knowing his interest in labour conditions, invited him to stand as Labour candidate for Parliament for the University of London. He agreed to do so, as he felt that his special knowledge might be of use under the present critical conditions; it was not political influence that attracted him, but merely a desire to give his best to his fellow-men; to quote his own words: "To one whose life has been passed in scientific research and education the prospect of entering practical politics can be no light matter. But the times are so ominous, the outlook, both for our own country and the world, so black, that, if others think that I can be of service in political life, I cannot refuse."

It seems almost superfluous to point out what a loss the death of Dr. Rivers is to psychology and ethnology. His keen critical mind and his insistence on scientific method were of inestimable importance to these young sciences; he, more than any one else, was establishing ethnology as a scientific discipline. It is impossible to indicate what his death means to his many friends.

A. C. HADDON.

DR. WILLIAM CARRUTHERS, F.R.S.

DR. WILLIAM CARRUTHERS, who died on June 2 at the age of ninety-two years, was a familiar figure in the botanical world in the latter half of the last century. He was born at Moffat, Dumfries, in 1830, and educated at Edinburgh with the view of entering the Presbyterian ministry, but decided in favour of a scientific career. In 1859 he was appointed assistant in the Department of Botany of the British Museum to J. J. Bennett, who had recently succeeded Robert Brown as Keeper of the department. In 1871 Dr. Carruthers followed Bennett in the Keepership, which he held until his retirement in 1895. His tenure of office was marked by a great development of the department. The removal of the natural history collections to the new museum in the Cromwell Road in 1881 afforded a unique opportunity for improvement and expansion; and the arrangement and equipment of the suite of galleries assigned to botany, including the great herbarium and the excellent botanical library, approached through a fine exhibition gallery, are a lasting memorial of Dr. Carruthers's knowledge and skill. The development of the Cryptogamic Herbarium, with the help of Mr. George Murray, and of the special British Herbarium, based on the collection of his chief assistant, Dr. Henry Trimen, the arrangement of the valuable collection of original botanical drawings and manuscripts, the planning of the exhibition galleries, and the initiation of a series of botanical monographs, such as Crombie's Enumeration of the British Lichens and Lister's Monograph of the Mycelozoa, may be recalled as incidents of his tenure. A fuller appreciation of these activities by another colleague, Mr. James Britten, will be found in the *Journal of Botany*, 1895.

Those who worked under Dr. Carruthers cherish pleasant recollections of the association. Always kind and sympathetic, he allowed his assistants full scope in the various sections of which they were placed in charge, and himself set an example of courtesy and helpfulness to visiting students and the casual inquirer. He had a strong sense of justice, and was prepared to uphold his views. Sundry hatchets, now happily buried, could testify to his capacity as a fighter.

Elected Fellow of the Linnean Society in 1861 (he has missed by one point the position of father of the Society), for more than forty years Dr. Carruthers took an active interest in its affairs. From 1886 to 1890 he was president, and his term of service included the centenary celebration in 1888. He took a great personal interest in Linnæus, and older fellows will remember the meticulous care with which he worked up the subject of the portraits of Linnæus for a presidential address. His doctorate, Ph.D. of Upsala University, was conferred on the occasion of the bicentenary celebration of the birth of Linnæus in 1907, at which Dr. Carruthers represented the Society. In 1871 he was elected a Fellow of the Royal Society, and in the same year was appointed consulting botanist to the Royal Agricultural Society, a position which he held until 1910. His yearly reports and other communications to this Society form a valuable contribution to the economic side of botany dealing with diseases of crops, pasture grasses, the purity and germinating capacity of seed, and the like. In this connection he established in his own house a seed-testing laboratory. Dr. Carruthers was also a Fellow of the Geological and Royal Microscopical Societies, and served as president of the latter; he was also president of the Biological Section of the British Association (1886) and of the Geologists' Association (1876).

The chief contributions made by Dr. Carruthers to pure science were in palæobotany, more especially the study of the carboniferous flora. The most productive period of these researches was in the 'sixties and 'seventies, and his monograph on the fossil Cycadean Stems of the Secondary Rocks of Britain (published in the Transactions of the Linnean Society, 1870), from which the genera Williamsonia and Bennettites date, remains a classic. Though his scientific work began almost coincidently with the appearance of the "Origin of Species," he was not attracted by the Darwinian theory, which he considered was not supported by the testimony of palæobotany. Dr. Carruthers was also

keenly interested in Puritan history and biography, for the pursuit of which study his retirement from the Museum in 1895 gave increased opportunity. His younger son, John Bennett Carruthers, who predeceased him, held important botanical posts in several parts of the Empire, Ceylon, the Federated Malay States, and Trinidad. A. B. R.

ADOLPHUS COLLENETTE.

MR. ADOLPHUS COLLENETTE, who died in Guernsey on May 7, in his eighty-first year, was an active worker in local climatology and physical geography, as well as an interesting personality, full of enthusiasm for the scientific point of view. His frequent expositions of scientific discoveries and theories in addresses, papers, and articles in the local society's transactions and the local press made him a well-known figure, and undoubtedly helped to arouse a good deal of scientific interest in an island which gives special opportunities for study. He was one of the moving spirits in what has now become the Société Guernesiaise, and his very active temperament made him one of its best-known guides in the long series of excursions which it has organised to teach its members the features of the Channel Islands. It is noteworthy that the research interest was well to the fore in this work. For many years Mr. Collenette kept detailed meteorological records in succession to those of the late Dr. Hoskins, so that the book he was writing at his death on the climate of Guernsey would have been based on observations registered continuously for nearly eighty years.

Mr. Collenette read a great deal of contemporary scientific literature and studied local details in the light of this reading. His was an attitude of courageous adventure; he made frequent suggestions criticising or modifying the theories of recognised authorities, sometimes with serious evidence to back him, always, at any rate, with the stimulation of discussion and further observation as a result of his work. Like Mr. Joseph Sinel of Jersey, he concerned himself especially with the relations of land and sea, and did a good deal towards the tracing of the raised beaches and some submerged beaches around Guernsey. One set is at maximum elevations between 23 and 30 feet, another varies between 46 and 65 feet; higher elevations range up to 75 feet. Mr. Collenette tried to identify platforms of marine denudation in connection with these beaches, and claimed to show that there were former sea-levels at practically all elevations from ordnance datum up to 300 ft.

While both Mr. Sinel and Mr. Collenette broadly accepted Mr. Clement Reid's view that the coast-level has been relatively stable during the past 2000 years, they nevertheless think that, in detail, there has been slow submergence around the Channel Islands within that period, and the evidence is by no means negligible. It was characteristic of Mr. Collenette that he upheld the view that Guernsey once had an ice-cap, and he claimed to show that Guernsey is rich in primitive implements, rostro-carinates and the like, including many made of crystalline rock. On this last point judgment must be left to the future.

Mr. Collenette gave attention to problems of local fruit-growing and contributed to research on tomato diseases. He was also honorary curator of the museum at the Guille-Allès Library and shared in its pioneer efforts for scientific education. It is greatly to be hoped that in the reconstruction which must follow his death, an effort will be made to combine all the local antiquities at the now public Lukis Museum, which is so important scientifically, and thus to permit the further development of the biological and geological collections at the older institution.

THE death on April 25 of Dr. Jenö Holzwarth, professor of radiology at the University of Budapest, is announced in the issue of the *Lancet* for May 20. Prof. Holzwarth studied at one time under Prof. Röntgen and afterwards acted as surgical radiologist in the clinic of Prof. Dollinger. During the earlier years, when insufficient protective appliances were in use, he suffered injuries which later developed into malignant disease. His chief contributions to the subject of radiology were on the therapeutic side, and his main papers are to be found in the *Orvosi Letil*, Budapest, during the years 1907–12. This publication appears to have ceased since the war.

WE much regret to record the death, on June 10, of Prof. William Gowland, F.R.S., emeritus professor of metallurgy, Royal School of Mines, in his eightieth year; also of M. Ernest Solvay, the distinguished industrial chemist and founder of the Solvay Institute of Chemistry, at the age of eighty-four years.

THE *Chemiker Zeitung* of May 27 announces the death of Prof. C. V. Zanetti, Director of the Institute of Pharmaceutical Chemistry and Toxicology in the University of Parma.

Current Topics and Events.

THE second conversazione of the Royal Society this year will be held in the rooms of the Society at Burlington House on Tuesday, June 20.

AT the annual meeting of the American Academy of Arts and Sciences, Prof. A. S. Eddington and Sir T. Clifford Allbutt were elected honorary foreign members.

THE annual conversazione of the Institution of Electrical Engineers will be held at the Natural History Museum, South Kensington, on the evening of Thursday, June 29.

THE unveiling and dedication of the War Memorial in memory of the members of the Institution of Electrical Engineers who fell in the Great War will take place at the Institution building on Wednesday, June 28, at 4.30 P.M. The memorial will be dedicated by the Rt. Rev. Bishop Ryle, Dean of Westminster, and unveiled by Air Chief Marshal Sir H. M. Trenchard, Bart.

MR. GEORGE F. BAKER, chairman of the board of directors of the First National Bank in New York, who has been a trustee of the Metropolitan Museum of Art for thirteen years, has endowed the museum with a capital sum equivalent to a quarter of a million sterling. The annual income from this, which may be estimated at 56,000 dollars, is to be at the disposal of the trustees. The expenditure of the museum in 1918 was 590,782 dollars, of which 233,000 dollars was contributed by the city of New York.

BY virtue of the Importation of Plumage (No. 2) Order, 1922, the names of certain birds (which are set out below) have been added to the schedule to the Importation of Plumage (Prohibition) Act, 1921, and their plumage can therefore be imported into the United Kingdom without special licence: The common jay; the common magpie; the common starling; the Java sparrow; the West African ring-necked parrakeet; the Chinese bustard; the Green (or Japanese) pheasant; the copper pheasant; and the golden pheasant. The Advisory Committee appointed under the Act, in recommending the addition of the names of the three last-mentioned birds to the schedule, further recommended that the matter should be referred to them again for review after the expiration of twelve months. The Board of Trade accordingly desires it to be known that the addition of these birds is provisional.

IT is announced in the *British Medical Journal* that a gift of 10,000*l*. has been made to aid cancer research by Mr. and Mrs. G. F. Todman, of Sydney, New South Wales, in memory of their daughter. At the request of the donors Sir Joseph Hood has allocated the sum as follows: 4000*l*. to the Imperial Cancer Research Fund, Queen Square, Bloomsbury; 1000*l*. each to the Middlesex Hospital, the Cancer Hospital, Fulham Road, London, the Christie Hospital, Manchester, the MacRobert Endowment, Aberdeen University, and the Cancer Hospital, Glasgow; and 500*l*. each to the Radium Institutes of London and of Manchester.

MR. F. N. PICKETT, chairman of the Management Committee of St. Paul's Hospital, 24 Endell Street, W.C.2, has placed a sum of 15,000*l*. in the hands of trustees to build, equip, and endow a new laboratory for research on various diseases which afflict mankind. The laboratory will be known as the "Pickett-Thomson Research Laboratory," and will be under the honorary direction of Dr. David Thomson, formerly research assistant to Sir Ronald Ross, who has consented to become president of the laboratory. Dr. Thomson, Mr. E. R. Davies, 10 Downing Street, and Mr. E. G. Martens, Genatosan Ltd., have been instrumental in getting a yearly income of about 1500*l*. for the upkeep of the laboratory staff, and other generous business men are now invited to help by giving the necessary money to endow a Ronald Ross research fellowship for biochemical researches on the nature of cancerous growths.

THE Association to aid Scientific Research by Women announces that at its recent annual meeting thirteen essays were submitted in competition for the thousand dollar Ellen Richards Research Prize. Of these essays six were from Great Britain, five from the United States, one from Australia, and one from a Russian working at research in New York. Since its establishment this prize has been awarded five times, three times to American competitors and twice to English competitors. While the prize for 1922 was not awarded, as in the opinion of the judges none of the essays were of the same grade as those to which the prize had been awarded previously, the judges gave such high credit to the paper submitted under the pseudonym of "Excited Atom" that the grant of 1000 dollars, together with honourable mention, was awarded to the author. This is the first time the grant has been made, and it carries with it the stipulation that "the grant shall be made only on the basis of submitted work and shall be used for the immediate continuation or completion of a definite piece of research." To these conditions the author of the paper entitled "An Investigation of the Critical Electron Energies associated with the Excitation of the Spectra of Helium, and their Significance in Relation to certain Modern Views of the Stationary States of the Helium Atom," has agreed, and therefore the sum of 1000 dollars has been sent to Miss Ann Catherine Davies, Royal Holloway College, Englefield Green, Surrey. Miss Davies holds the B.Sc. degree from the University of London, 1915, and received the M.Sc. degree from the same University in 1917.

CAPT. R. AMUNDSEN left Seattle on June 3 in his schooner *Maud* for the Arctic. Before his departure he announced a change in the plans of the expedition. His original intention was to enter the pack-ice north of Bering Strait and drift across to the Atlantic side, a journey which might occupy from two to four years. Last year the *Maud* made an attempt to begin this drift, but sustained injuries which necessitated her return to port. The *Times* announces that Capt. Amundsen now intends to attempt a flight across the polar basin from Point Barrow, the most northerly point of Alaska, *via* the North Pole, to Cape Columbia in Grant Land, where a depot of food has been placed in readiness. The distance is about 1550 nautical miles, and Capt. Amundsen hopes to accomplish it in fifteen hours. Sledging outfit and provisions will be carried in case a descent on the ice is necessary. His sole companion will be the pilot, Lieut. O. Omdal, and the machine will be a Larsen plane built entirely of metal. This aeroplane has already shown that it can remain in the air for thirty-two hours. Provided the weather is clear, this aeroplane reconnaissance should settle the possibility of the existence of unknown islands in the Arctic Ocean. Capt. Amundsen hopes to be able to rejoin the *Maud* next year, and apparently intends to continue the detailed exploration of the polar basin.

NEWS from the Mount Everest expedition published in the *Times* announces that on May 21 Messrs. Mallory, Somervell, and Norton reached an altitude of 26,800 ft. on the northern side of Mount Everest.

This climb was by way of a reconnaissance and did not entail the use of the oxygen apparatus. The height attained is some 2200 ft. below the summit of the mountain, and also about 2200 ft. above the previous record in height, 24,583 ft., which was reached some years ago on K2 by the Duke of the Abruzzi. General Bruce announces that the whole expedition reached the base camp at Rongbuk glacier, at a height of 16,600 ft., at the end of April. An advanced base was established under the peak of Changtse at an altitude of 21,000 ft. The Great Lama of Rongbuk monastery, which is one of the holiest monasteries in Tibet, received General Bruce and several other members of the expedition, and put the most searching questions as to the reasons for attempting the climb. The Lama was satisfied with the view that the attempt was largely in the nature of a pilgrimage, and he gave the expedition his blessing.

Further despatches from Gen. Bruce give details of the fortunes of the Mount Everest expedition before the date of a climb to within some 2000 feet of the summit of the mountain. The weather improved in May, but new difficulties that had to be faced were the desertion of some of the local coolies and the appearance of a mild form of influenza. Yet good progress was made. Gen. Bruce describes the reconnaissance that led to the discovery of a route leading towards the Chang La or North Col of Mount Everest, and the establishment of a camp (No. 3) at 21,000 feet on a broad moraine-covered shelf under the high cliffs of the north peak of Changtse. Col. Strutt, who led this reconnaissance, reports on the difficulties in ascending the East Rongbuk glacier and particularly the side glaciers. But Major Morshead contrived to find a feasible route, and all available hands were to carry supplies up to this advanced base while Messrs. Mallory and Somervell were prospecting the route up to the North Col which was subsequently discovered. In commenting on the weather conditions, Gen. Bruce expresses the opinion that there are normally only two months of suitable weather for climbing in the region of Everest in comparison with at least four months in the West Himalayas. Dr. Longstaff thinks this estimate optimistic, and believes that there is only one month of really suitable weather.

A FULL account of the *Quest's* Antarctic voyage is published in the *Times* in articles by Mr. F. Wild, who is in command of the Shackleton-Rowett expedition. These articles amplify earlier telegraphic despatches. The *Quest* evidently had her full share of the notoriously stormy weather of the Southern Ocean, but, with able handling, avoided any serious mishap. She is evidently of too low power to be of much use among close and heavy pack, but, on the other hand, her small size makes her very suitable for investigating uncharted islands which lie clear of the ice. The visit to Zavodovski Island, the most northerly of the South Sandwich group, did not include a landing, and the weather was too misty to allow a determination of the height. Mr. Wild reports that the island has no good anchorages and very few landing-places. Volcanic activity was noticeable. At the conclusion of the cruise across the Weddell Sea, a visit was made to Elephant Island, where several landings were effected and some geological work carried out. Geological work was also done in Cooper Bay and other bays on the northern side of South Georgia. In addition to the soundings in the Southern Ocean and Weddell Sea, several lines of soundings have been taken off the coast of South Georgia. After calls at Tristan da Cunha and Gough Island, where landings will be made if weather permits, the *Quest* will sail for Cape Town, where she should arrive this month.

THE report of the council of the Illuminating Engineering Society, presented at the Annual Meeting on May 25, contained a summary of useful work, a feature being the variety of topics dealt with during the session and the opportunities afforded for co-operation with other bodies. Thus "The Use of Light in Aerial Navigation" was discussed at a joint meeting with the Royal Aeronautical Society, "The Lighting of Public Buildings" in conjunction with the Royal Institute of British Architects, and the "Use of Light in Hospitals" in co-operation with the Royal Society of Medicine. Attention is also directed to the resumption of international relations in the scientific world, an event of special interest last year being the first technical session of the International Illumination Commission, at which many countries were represented. The presidential address delivered by Sir John Herbert Parsons also aptly illustrated the need for co-ordination of physical and physiological science. As an eminent ophthalmic surgeon, Sir John is familiar with the complexities of vision, and was able to show how important a knowledge of this subject is to the proper study of such problems as photometry and the effect of "glare"—the latter a consideration which enters into daily life in many ways, notably in the use of artificial illuminants and the effect of motor-car headlights.

IN a paper on "The Indigo Situation in India," read on March 24 before the Royal Society of Arts, Prof. H. E. Armstrong criticised strongly the decision of the Government of India to discontinue the work of the Indigo Research Chemist appointed in 1916, and expressed the fear that the action taken resulted not from the prevailing need for retrenchment, but from an inability to appreciate the issues at stake. It will be recalled that Mr. W. A. Davis was appointed to investigate the whole question of indigo production in India, and that arrangements were made for his first inquiries to be concentrated on the preparation of an indigo paste of standard strength and satisfactory fineness of division which would enable the Indian product to compete successfully with the German synthetic indigotin. In spite of special difficulties resulting from the war, a satisfactory product was prepared and Indian indigo paste now has a ready sale in this country. Since 1917 the larger question of the elucidation of the biochemical processes involved in the extraction and manufacture of

indigo from the plant has been tackled, as Prof. Armstrong showed, with marked success. The research has a practical value far beyond the indigo question, since it connotes the systematic study of the physiology of a leguminous crop, thus helping to fill a lacuna in agricultural science widely recognised as one calling for early attention in view of the great economic importance of leguminous plants. In the discussion of the paper the chairman (Sir Thomas Holland), while recognising the financial difficulties of the Indian Government, deplored the decision to stop this promising research, and suggested that the funds required from the Government for its continuance would be essentially of the nature of a loan, since the special export cess levied in 1918 for assisting research on indigo could be made to support the cost of the investigation.

A SMALL brochure on "Safety First" in X-ray work, issued by Messrs. Watson and Sons, Kingsway, shows that the recommendations of the X-Ray and Radium Protection Committee have not been in vain. The two Memoranda which have been issued by this Committee are reproduced *in extenso*, and it is evident that Messrs. Watson are doing their best to induce their clients to accept the protective measures prescribed. This is a welcome step in the right direction, for if radiological work throughout the country is to be free of risk to those engaged in it, it will be brought about only by those in charge of the installations insisting upon guarantees of safety. These guarantees can be provided at a small percentage cost of such installations, and we look confidently to the time when the National Physical Laboratory Certificate of Safety will become a *sine qua non* for practical work of this character.

SIR WILLIAM TILDEN and Prof. J. C. Philip are editing for Messrs. George Routledge and Sons, Ltd., a new series of volumes dealing with chemistry. Those for which arrangements have so far been made are :—"The Metastability of Matter," Prof. E. Cohen ; "Oxidation and Reduction in Organic Chemistry," Dr. O. L. Brady ; "Physical Aspects of Organic Chemistry," Prof. T. M. Lowry ; "Atomic and Molecular Structure in Relation to Properties," Dr. I. Langmuir ; "The Energy Factor in Chemical Change," Prof. J. R. Partington ; "Space Formulæ in Carbon Compounds," Prof. J. F. Thorpe and Dr. C. K. Ingold ; "Adsorption," Prof. J. W. M'Bain ; and "The Theory of Quantitative Analysis and its Practical Application," Prof. H. Bassett.

Our Astronomical Column.

A VERY MASSIVE STAR.—A paper by Prof. Plaskett on a spectroscopic binary of very high mass was read by Prof. Newall at the meeting of the Royal Astronomical Society on June 9. The star is of the sixth magnitude, and shows two spectra with considerable difference of brightness, but both measurable. It is difficult to imagine any explanation of the double spectrum other than duplicity of the star, as the spectral type indicates a fair amount of condensation, and the distance between the stars is of the order of half an astronomical unit. As there is no evidence of light-variation, it is presumed that eclipses do not occur ; it is therefore estimated that we see the orbit open to the extent of some 15°. The minimum values of the masses are given as about 70 times that of the sun for each component, the combined mass being about four times as great as that of any previously determined.

THE ROTATION PERIOD OF MARS.—Mars is the only planet of which the rotation period is exactly known. The periods of Jupiter and Saturn are often confidently stated to the fraction of a second, but it must be remembered that these values represent merely the rates of drifting and changeable spots in the vaporous envelopes of the two planets. We cannot perceive anything of the material features forming the real surface scenery of either Jupiter or Saturn, for they appear to be continuously veiled.

Mars, however, displays its actual surface markings to our view. We detect objects on its disc which are similar in shape and position to those which were discovered and delineated by Hooke, Cassini, and Huygens in the last half of the seventeenth century. There can be no doubt that the markings seen today are identical with those traced by the old observers about two and a half centuries ago.

The rotation period of Mars, according to the best determinations, is 24 hours 37 minutes 22·6 seconds, but there is a suspicion that this is too long, to the extent of about one-twentieth of a second.

RADIAL MOTIONS OF SPIRALS AND CLUSTERS.—C. Wirtz contributes an article on this subject to *Astronomische Nachrichten*, 5153. He quotes figures for 29 spirals of which only four show approach, and deduces a systematic recession of 840 km./sec., finding for the sun's velocity 712 km. towards R.A. 54°, N. Decl. 83° ; galactic Long. 95°, N. Lat. 23°. Omitting two doubtful figures the velocity, longitude, and latitude become 693 km., 90° and 29°, a shift of 7° from the first result. It appears that the nebulæ in lower galactic latitudes tend to approach, those in high latitudes to recede, while the brighter ones (that is, either the nearer or the more massive ones) tend to approach and the fainter ones to recede.

The radial motions of ten globular clusters indicate a systematic approach of 55 km./sec., and give a solar velocity of 348 km. towards R.A. 11°, N. Decl. 77°, galactic Long. 90°, N. Lat. 15° ; or, omitting the systematic motion of approach, the velocity, longitude, and latitude become 373 km., 79° and 19°, only 12° from the first point. The number of clusters is too small for trustworthy analysis, but there is some evidence of greater velocity in low galactic latitudes, and of increasing velocity with increasing distances (using Shapley's parallaxes). There is an interesting resemblance between the apices derived from spirals and clusters, but the great difference in velocities leaves it doubtful whether it has any significance.

The author points out that trustworthy proper motions of the above spirals would enable a good estimate of their distances to be derived ; a preliminary analysis of the few proper motions available (*Astronomische Nachrichten*, vol. 206, p. 114, 1918) gave for the solar apex R.A. 110°, N. Decl. 34°, annual motion 0·027″. This point is 52° distant from the first point found from radial motions. This discordance is not too discouraging considering the meagreness of the material, and the large discordances that are found for the apex relatively to the stars belonging to the galactic system.

Research Items.

A DOG-TOOTH BREAST ORNAMENT.—The *Australian Museum Magazine* (vol. i. No. 4) gives an account, with a photograph, of a remarkable form of breast ornament procured at Rabaul, New Britain, and now on loan at the Museum. It consists mainly of canine teeth of the island dog, the teeth having been perforated and attached to a plaited fibre string base, 22½ by 7¾ inches in size. At the angles and upper centre are pendants made of teeth and shells. As only four canine teeth occur in an individual, at least 130 dogs contributed to the ornament. When worn by the chief, it is suspended from the neck by the attached finely plaited cord. It was considered of great value, and no doubt formed an heirloom of much importance.

THE CHUCHKI NATIVES OF NORTH-EASTERN SIBERIA.—In the Journal of the Washington Academy of Sciences (vol. xii. No. 8, April, 1922), Mr. H. V. Sverdrup gives an account of the Chuchki tribe, collected on Capt. Amundsen's expedition, which left Norway in 1918 with the intention of following the coast of Siberia eastward to the vicinity of Bering Strait. At Ayon Island, about 700 miles west of Bering Strait, the Chuchkis were found in possession of herds of domesticated reindeer. The tents in which they live, summer and winter, are well adapted to their nomadic life and climatic conditions, and they are heated by a flat lamp of the Eskimo type. Reindeer supply practically all their food, the animals being caught with lassoes which the young men handle with wonderful skill. They do not count years, so nobody knows his own age, but they count thirteen full moons in the year by the twelve joints on both arms from the finger tips to the shoulders, including the head for the thirteenth month. They kill old people, not through cruelty, but as an act of mercy. His sledge, axe, knife, tobacco pipe, and teacup are buried with a dead man. They are quite contented with their mode of life, and have no desire to change their habits or leave their country. They do not care for the outer world, so long as it is willing to exchange tea and tobacco for fox skins. "Civilisation would not bring them any good, so it would be well if they might remain as primitive as they are."

HEALTH IN THE TROPICS.—A paper on climate and health in the South American tropics by Dr. F. L. Hoffman was presented before the American Meteorological Society at Toronto in December 1921, and a summary is given in the *U.S. Monthly Weather Review* of January last. The author considers that false impressions prevail as to the climate of the Amazonian basin, and much which has been written is misleading and a deterrent to the settlement of a vast region with enormous economic possibilities. The climate is warm throughout the larger portion of the year, but the warmth is limited mostly to the daytime, while the nights are often distressingly cool. The chief causes of ill-health in northern South America are apparently not tropical diseases but respiratory and rheumatic affections. Chilly nights cause ill-health and result in a high mortality. It is estimated that the night temperatures are about 30° lower than the day readings. With regard to humidity, it is stated to be generally far from such a serious detriment to health and comfort as is assumed, but when a high humidity coincides with a high temperature there is a considerable increase in infant mortality.

MOSQUITO INVESTIGATION.—Of the three species of Anopheles mosquitoes capable, under certain conditions, of communicating malaria, two, *i.e. A. maculipennis* and *A. bifurcatus*, stand convicted. The third group, *A. plumbeus*, or *A. nigripes*—a sylvan species—has been less known, although strongly suspected. Recent investigations by Blacklock and Carter of Liverpool, however, tended to establish not only the possibility of their capabilities as disease carriers, but that they were more abundant in England than had been supposed. Following up this discovery, the Mosquito Investigation Committee of the South-eastern Union of Scientific Societies has for nearly two years been engaged in inquiring into the habits, breeding places, and distribution of the species in south-east England, at the instance of the Ministry of Health. The three reports of the Committee have established that the larvæ of the species is extensively distributed in certain areas, many breeding places having been located, and that eggs, after becoming dry, hatch on re-immersion. Thus drought will not destroy them. The final report to the Ministry of Health is nearly due, the Committee has issued a Circular (No. 6) with the object of clearing up some points still in doubt. The more important are:—(1) Whether the species deposit their eggs (*a*) on water, (*b*) on floating or stationary objects, or (*c*) on the wet margins of water-holes. (2) The retention of vitality of the eggs after desiccation. (3) Information as to the possible hibernation in the egg stage. We may add that the late Mr. A. W. Bacot, whose death in Egypt last April, while engaged on typhus research for the Egyptian Government, was so tragically sudden, was the chairman of, and took great interest in, the Committee's work. The present chairman is Dr. Clarence Tierney, and the hon. secretary is the Rev. T. W. Oswald-Hicks of Lesware, Linden Road, N.15, who will be glad of replies to any of the queries.

THE SMALLEST HORNED DINOSAUR.—After skilful work extending for over a year, Mr. Norman Boss has completed and mounted for the U.S. National Museum a restored skeleton of the smallest horned dinosaur that has yet been discovered. This skeleton of *Brachyceratops montanensis* is the subject of a short description, with illustrations by Mr. C. W. Gilmore (Proc. U.S. Nat. Mus., vol. lxi.). The original remains from the Upper Cretaceous of north-western Montana, first described in 1917 (U.S. Geol. Surv. Prof. Paper 103), have been supplemented where necessary from other sources and result in the building up of an individual, admittedly immature, 5 ft. 4 in. long (the skull contributing 22 in.) or about the length of the head alone of Triceratops, as shown in the view of the two skeletons juxtaposed. The height of Brachyceratops at the hips is given as 30 in., but we cannot help thinking that like other of these American reptiles of olden days it has been mounted too upstanding. In a model representing the animal in the flesh (also here figured) an attempt has been made to depict the character of the scaly skin.

FOSSIL BIRDS FROM PORTO RICO.—The "Bird Remains from the Caves of Porto Rico" have been investigated and described by Mr. A. Wetmore (Bull. Amer. Mus. Nat. Hist., vol. xlvi.). The specimens were obtained in 1916 by Mr. H. E. Anthony in connection with a natural history survey of the island of Porto Rico, undertaken by the New York Academy of Sciences in co-operation with the Insular Government of Porto Rico. The number of species is 42, of which six were described as new at intervals during 1918 to 1920, the diagnoses being here repeated, while seven belong to extinct forms. The great mass of bones appears to have come from owl pellets; those of birds larger than a thrush or blackbird are comparatively few in number,

and may have represented the prey of man, or have been introduced by accident. They vary in age, the author considers, from 100 to more than 2000 years.

MOTOR HEADLIGHTS WITHOUT GLARE.—Some researches on motor headlights were summarised by Mr. H. S. Ryland at the recent discussion on this subject before the Optical Society (NATURE, May 27, p. 694). Mr. Ryland remarked that glare was largely a matter of comparison. Two of the chief factors, the "after image" effect and the regions of insensibility surrounding the image of a bright object, varied with the size of that object. He concluded from his experiments that for a given brightness of the beam, glare varied as the square of the apparent diameter of the course. Mr. Ryland has accordingly designed a lamp with a 2 in. aperture, all the available light (less about 4 per cent. and the ordinary reflection losses) being included in the beam, the upper limit of which is normally horizontal. Tests on the road showed that such lamps yielded adequate illumination and yet could be passed by other road users without discomfort.

EFFECT OF STRESS ON THE HEAT CONDUCTIVITY OF METALS.—The measurements of Smith in 1909 (*Physical Review*, vol. 28, p. 107) and those of Johnstone in 1916 (*Philosophical Magazine*, vol. 29, p. 195) on the effect of stretching on the conduction of heat along wires showed that for most of the commoner metals stretching increased the conduction by about 7 parts in a million for each megadyne per sq. cm. of stress up to the elastic limit. Lussana's measurements in 1918 of the effect of hydrostatic pressure on the conductivity (*Nuovo Cimento*, vol. 15, p. 130) gave increases as the pressure increased at approximately the same rate up to pressures of about 3000 megadynes per sq. cm. In the April issue of the Proceedings of the American Academy of Arts and Sciences, Dr. Bridgman gives an account of his recent measurements of the effects of pressures up to 12,000 megadynes per sq. cm. on the heat conductivities of eleven metals. He finds that pressure increases the conduction in the case of lead, tin, iron, and decreases it in the case of copper, silver, nickel, bismuth and antimony. The rates of change lie between 2 and 12 parts in a million per megadyne increase of pressure.

REGULATING RESISTANCES. — A comprehensive catalogue of regulating resistances, ranging from large banks of grid resistances to small adjustable rheostats, has been issued by Messrs. Isenthal and Co. (Denzil Works, Willesden). The method of construction of a tightly wound single layer of bare wire on an insulating cylinder with a spring sliding contact of ample dimensions moving axially over the wire, is adopted up to quite large sizes for field regulating resistances of the type in which only the regulating hand wheel is in front of the board. These are made, either with a slow motion screw gear, or actuated by wires so that one turn of the wheel covers the whole range. Dimmers for incandescent lighting with the same type of resistance are also illustrated. The large grid type resistances are made up in a variety of forms for different purposes, such as meter calibration, artificial loads, and other testing work. In many of these, control is effected by putting a varying number of sections in parallel by a circular switch of substantial construction with a moving contact segment, which passes under a series of radially disposed carbon contacts resembling dynamo brushes in holders of the box pattern.

VISCOSITY AND FLASH-POINT APPARATUS. — Messrs. Gallenkamp of 19-21 Sun Street, Finsbury Square, have sent us an illustrated pamphlet describing standard apparatus for determining the viscosity and flash point. The increasing importance of petroleum products for motor fuel, lighting, heating, and lubricating purposes, together with the fact that the industry is rapidly assuming considerable proportions in this country, renders the possession of accurately standardised testing apparatus a matter of great interest, and Messrs. Gallenkamp are to be congratulated on their foresight in putting before the laboratory staffs of the oil refiner and the oil consumer the useful compendium under notice. It is unfortunate that this country, the continent of Europe, and the United States have each developed a type of viscometer which at best is merely empirical. All suffer from the drawback of a capillary far too short which is difficult to clean, and none of the instruments give absolute readings. The tables of comparison between the three types, Redwood, Engler, and Saybolt, are only approximately correct, and the range of observations is relatively narrow. Until, however, a universal viscometer has been devised the three instruments mentioned will retain their places. The pamphlet gives instructions for using Redwood's viscometer and might very well have added concise instructions for the operations of the other two. The recently described instruments of Stammer and Michell are also described and quoted. The list includes the well-known flash-point apparatus of Abel, Abel-Pensky, and Cray, and the standard distillation tests of Engler and the British Engineering Standards Association.

A CRYSTALLOGRAPHIC INDEX.—"A List of New Crystal Forms of Minerals," by Dr. Herbert P. Whitlock, was issued in April (1922) as a separately bound brochure, from the Bulletin of the American Museum of Natural History (vol. 46, Art. II., pp. 89-278). Such a systematic compendium of new crystal "forms" (groups of faces of equivalent value with respect to the symmetry) should prove of great value. Often it is very difficult, when measuring crystals of known minerals from new localities, or crystals exhibiting specially interesting features although from known localities, to be quite sure, on discovering what are apparently new and hitherto unobserved forms, that these forms have in truth never been previously observed. Crystallographic literature is now so voluminous and complex, so scattered in so many different publications, that it is a matter of great labour to be thoroughly conscientious in seeking for previous records of the observation of these possibly new forms. Indeed, it frequently happens that such a search is not as thorough as the case requires, and in the actual compilation of this list Dr. Whitlock has found many cases where forms cited as new, and forming the sole subject of a paper supposed to be of original investigation, have proved to have been previously described—and more than once—by other authorities. The scope of the compilation includes the thirty years from 1890 to 1920. The thanks of both mineralogists and crystallographers are due to Dr. Whitlock for so useful a production, which is rendered all the more valuable by the fact that full references to all the original authorities are given. Together with the abstracts of crystallographic papers which are being published by the Mineralogical Society of London, and the lists of new minerals and new forms which from time to time are being included in the *Mineralogical Magazine*, we have now the material in compact form wherewith to set in order the whole record of crystallographic achievement, and to remove the stigma of "chaotic literature" which has been with some truth attached to the literature of this subject in the not too distant past.

Iron Ore in Europe.[1]

By Prof. J. W. GREGORY, F.R.S.

THE political redistribution of the iron ores and coal supplies of Central Europe by the late war was one of the results of most portentous import to the future of the world. A clear summary of the available evidence by a well-qualified expert who represents so impartial an authority as the Geological Survey of the United States, is a valuable addition to the literature of political geology. The evidence on which the memoir is based is of very unequal value, for any individual synopsis of the iron ore position must be based on the published records, which are of varying quality in different countries; moreover, the author remarks that the Russian and Slavonic literature is available to him only at second hand.

Despite its deficiencies, inevitable in any review of the ore supplies of a continent which is such a political patchwork as Europe, Roesler's memoir is a valuable supplement to the monograph on the iron ores of the world which was published in 1910 by the International Geological Congress. Mr. Roesler has brought the information up to date and presents it in a more compact form. Moreover, he expresses the results graphically in a series of sixteen clear and instructive maps which show the distribution of the ore fields and the known and estimated qualities of ore in each.

The outstanding feature of the present position is the overwhelming predominance of France in Europe as regards supplies of iron ore. In this respect France among the nations of the world stands second only to the United States. "France has the largest reserves. She stands so clearly above the other countries of Europe that there is no question of her holding first place." The French known, probable, and possible iron ores are estimated at a total of 4,369,600,600 metric tons, a total which amounts to 35·2 per cent of the iron ore reserves of Europe; the British Isles take the second place with 18·2 per cent., Sweden is third with 12·5 per cent., the German Republic fourth with 11·1 per cent. According to the author's classification of European countries Spain is fifth with 5 per cent., for he subdivides Russia, with a total of 8·3 per cent. into the Central, Southern, and Ural regions. The Russian iron fields are so scattered that it is a great convenience to keep them distinct, for they may be developed as separate industrial areas each supplying a different group of provinces.

The British supplies accepted by Roesler are smaller than some estimates; he admits that the iron included in these estimates is present, but he considers that some of the material is of so low a grade that it should not be regarded even as possible ore. He remarks that his own figure for possible ore, 2254 million metric tons, may be too large.

Germany has fallen to the fourth place, and the unfavourable conditions of a large proportion of its ore has led to the prediction that it cannot be worked and that the future of Germany is "only that of an agrarian state." The author dismisses this hypothesis with the remark that Germany "has shown her capacity to use her resources thoroughly enough to justify the conclusion" that the ores left her will be fully exploited.

The large volume of French ores is due to the sedimentary ores in the Jurassic field of Lorraine. The sedimentary ores of Europe range from the pre-Cambrian beds at Krivoi Rog in Southern Russia to the Pliocene ores of Kerch in the Crimea, and representative beds occur in most of the geological periods; but the most important supply comes from the Jurassic, which contains 46 per cent. of the European sedimentary ores. These ores contribute 70 per cent. of the total; the replacement ores amount to 12 per cent.; the contact deposits and magnetites, of which the genesis is doubtful, amount to 16 per cent.; in reference to these ores the author appears to have overlooked the fact that some of the large Lapland masses consist of titaniferous magnetite, and to overstate the strength of the case for the magmatic origin of the Kiruna ores.

The iron ore reserves are best known in Europe, and taking this quantity as the unit, the supply in North America would be represented by three, in South America by two, in Asia by three-quarters, and in Africa by one-sixth. In both Africa and Asia, however, the amount may be expected to be increased greatly by further exploration.

The reserves of iron ore in the world are estimated as sufficient to maintain the production of 1913 for 1000 years; but if the output of iron increases at the pre-war rate of 5 per cent. per annum, the supply would be exhausted in about 130 years; but a fall in the rate of increase appears inevitable, and consequently the ore reserves will have a longer duration.

The progress of the iron industry is of primary importance to the world and its future, and is especially difficult to forecast. Hitherto, Europe has had the advantages over the United States of cheap labour and of the proximity of ore and coal. In spite of this, the United States has gained the supremacy in the iron industry through economy in labour by mass production and through the large local market for manufactured goods which is maintained by the high wages paid. Europe has now to face conditions when labour is no longer cheap, and when the low efficiency that accompanies low wages cannot be as quickly altered. The main European iron field is now separated politically from the Westphalian coal field. The part of the Lorraine field which was French before 1914 was handicapped by lack of labour, and most of the miners were Italian; and unless adequate labour can be secured for the mines, and the Westphalian coal and the Lorraine iron can be brought together under favourable economic conditions, the development of the field will be jeopardised. The Belgian iron industry is dependent on German coal and on imported ore. Austria has no coal, and her considerable iron ores will probably be exported to feed the German furnaces. The three chief ore-exporting countries, Sweden, Spain, and Norway, will probably be but little disturbed by the new conditions, which will help the Norwegian ores, since most of them need concentration and briquetting.

The large British reserves of ore, though they have the advantage of proximity to coal, may be useless should the high price of fuel render it profitable only to melt high-grade ores which must be imported. The British iron industry will no doubt adjust itself to the new conditions, but Mr. Roesler predicts that the transition will be troublesome and painful. The outlook of the iron industry in this country is indeed dismal if costs of production can be lowered only at the expense of coal and labour. That there are opportunities for saving in other ways appears clear from the fact that whereas in the United States each blast furnace has an output of 120,000 tons per annum, in Germany it is 55,000 tons, and in England only 28,000 tons.

Mr. Roesler's work concludes with an excellent bibliography.

[1] "The Iron-Ore Resources of Europe," by Max Roesler, Dept. of the Interior, U.S. Geol. Surv. Bull. 706, 1921, pp. 152+xix. pls.+32 figs.

The Photographic Plate.

THE third Hurter and Driffield memorial lecture was delivered in the theatre of the Royal Society of Arts, before the Royal Photographic Society, on May 9, by Prof. The. Svedberg of Upsala, who took for his subject "The Interpretation of Light Sensitivity in Photography." After a short general discussion of light sensitiveness from a purely photochemical point of view, particularly with regard to Einstein's law of the photo-chemical equivalent, the lecturer distinguished between *plate*-sensitiveness, *grain*-sensitiveness, and sensitiveness of the *silver-halide material* of the grain. The first is the sensitiveness that concerns the practical photographer, but the third, together with some purely physical circumstances, determines the quality of the plate, and is that to which the emulsion maker should devote most of his attention. It has been recognised only quite recently that there is a sensitiveness of the haloid which is independent of the physical properties of the film and of the size of the grains or particles.

From a statistical point of view, and with single emulsions, that is emulsions prepared at once and unmixed with other emulsions, there is a certain relationship between sensitiveness and the size of the particle, the larger grains being more sensitive than the smaller. But though the probability for a grain to become developable is greater in the case of a large grain than in the case of a smaller one, yet taking any two individual grains one cannot tell whether, on exposure, the larger or the smaller will be the first to become developable. This is accounted for by the fact that development sets in at discrete points in the halide grain and progresses from these points until the whole of the grain is converted into metallic silver. One such starting-point is sufficient to render the grain completely developable.

These centres of action are located and counted by stopping development at a very early stage, and superposing a photograph of them on a photograph of the same particles taken in a deep red light before the exposure. A statistical study of the distribution of these centres gives the interesting result that within each size-class of halide grains they are distributed according to the laws of chance. The lecturer adds, "Whether the developable centres are pre-existent in the grains in the form of especially light-sensitive points, or whether their number and position in a grain is entirely determined by the light only—eventually by the haphazard distribution of the light quanta—we are so far not able to tell."

For various size-classes of grains in the same emulsion, the average number of centres increases with the size of the grain. This leads to the assumption that as a rule all the grains of a single (unmixed) emulsion are built up of the same silver halide material of the same light sensitiveness, the larger grains being more sensitive than the smaller ones merely because of the greater probability that a larger grain may contain one, or more than one, developable centre. The average number of centres is found to be proportional to the surface area of the grains.

By the use of X-rays, which are so little absorbed that the grain is exposed to their action through its whole mass, the available centres are found to be on the surface of the grain, so that the sensitiveness of a grain is determined entirely by its surface layer. By finding the number of centres per unit area of grain surface it is possible to find the sensitiveness of the silver halide material of an emulsion, independently of the size of its grains, and this has been done for three different emulsions, demonstrating clearly the great differences in sensitiveness to light of the haloid bromide material in different emulsions. Such estimations are likely to be of value to the emulsion maker in his endeavour to prepare emulsions of new and desirable properties.

The lecturer concluded his discourse by pointing out many questions that still remain to be answered in order to perfect our knowledge of the photographic plate and its sensitiveness to light. C. J.

Agricultural Research at Aberystwyth.

THE new agricultural buildings and the Welsh plant-breeding station of the Agricultural Department, University College of Wales, Aberystwyth, were formally opened on May 20 by the Minister of Agriculture, the Rt. Hon. Sir Arthur Griffith Boscawen, Bart.

The Welsh plant-breeding station owes its origin to the foresight of Sir Laurence Philipps, Bart., of Llanstephan House, Boughrood, Radnorshire, who generously provided an endowment of 10,000*l.* for the purpose, and who further assists the station with an annual donation of 1000*l.* to its funds for a period of ten years. In 1920 the station was recognised by the Ministry of Agriculture as a research institution entitled to grants-in-aid from the Development Fund, and by virtue of a capital grant and annual grants-in-aid in addition to Sir Laurence Philipps's generous endowment, it has been possible to equip the station in a thorough and up-to-date manner.

The work in connection with the new agricultural buildings and the plant-breeding station was started in 1919. The buildings are now completed and consist of commodious and well-equipped laboratories for research in agricultural botany and agricultural chemistry, as well as lecture rooms, and a library. The laboratories of the plant-breeding station are also arranged for in the buildings and have been specially equipped in a manner suitable for the researches which are in progress. The buildings occupy the site of the old foundry near the station—practically all the laboratories and lecture rooms being, in fact, part of the original building—the alterations having been skilfully made by Mr. Bassett. In addition to the self-contained building which is now solely occupied by the Agricultural Department, Nantcellan Farm, Clarach, has been acquired for the use of the teaching department, and Frongoch Farm for the Welsh plant-breeding station. The former is situated in the Clarach Valley about three miles from Aberystwyth. It comprises about 142 acres of pasture and arable land together with about 28 acres of woodland. The main object of the farm is to furnish facilities for giving demonstrations to students and for carrying on experiments and research. It is considered eminently suitable for the purpose for which it was obtained. The latter is a farm of 92 acres and is used entirely for experimental purposes in connection with the Welsh plant-breeding station. In addition, the plant-breeding station has about 5 acres of garden ground situated a few minutes' walk from the laboratories. At the gardens the equipment consists of a large span greenhouse and an up-to-date pot culture station, together with cages and other essentials.

The formal opening marked a great advance in the facilities afforded in Central Wales for both the student and for research in the problems influencing productivity in the Principality. The investigations

conducted at the Welsh plant-breeding station are primarily intended to be of service to agriculturists in Wales, and are therefore bound to be of equal value to farmers generally in elevated areas in regions of high rainfall.

The chief aim of the station is to investigate problems connected with herbage plants with the view of producing improved strains of such important plants as red clover, lucerne, the rye grasses, cocksfoot, and all other grasses suitable for inclusion in mixtures for temporary and long-duration pastures. Researches on these lines are now well advanced, interesting reports having been issued from the station on the work so far conducted. The oat crop is also receiving detailed attention; the possibility of extending the practice of growing winter oats is being explored, and endeavour is being made to produce hardier, earlier, and stiffer-strawed varieties suitable to Welsh conditions. It should be stated that the potato, barley, and root crops are not being studied at the station.

Welsh agriculturists must not expect to see the full benefits from Sir Laurence Philipps's foresight and the developments that have followed from the foundation of the station until after the lapse of a number of years—for plant-breeding is a slow and laborious business based on the gradual building up of strains each of which can only be the outcome of prolonged investigation.

The Royal Observatory, Greenwich.

THE report of the Astronomer Royal presented at the annual visitation of the Royal Observatory, Greenwich, on June 3, deals with the year ended on May 10. The observations for the seven-year star catalogue, 1915–1921, have been concluded, practically all the stars having been observed at least seven times; they include all stars in the Backlund-Hough list north of declination −28°. The determination of their proper motions is now in progress. The working catalogue in use since January last includes all the stars brighter than the eighth magnitude (with some fainter ones in sparse regions) between North Decl. 32° and 64°. It will be remembered that the zones from N. 24° to N. 32° and from N. 64° to N. 90° were covered in recent Greenwich catalogues. The epoch 1925 is adopted for all catalogues about the present time, in accordance with a resolution of the Astronomical Union.

A change has been made in the method of determining azimuth error of the transit-circle. Formerly it depended upon observations of the nine standard polars within 3½° of the pole; a list has now been made of 70 stars the polar distances of which lie between 13° and 45°, most of them bright enough to be observed in daylight; as many of these as practicable are observed daily at both culminations, using the travelling-wire micrometer, thus greatly reducing the personality that was present in the previous method of hand-tapping used for the close polars. The latter stars will still be observed for place; their positions will no longer depend solely on double transits of Polaris, which were only obtainable for restricted periods of the year. The clock-star list has been modified by removing two very low stars and inserting eleven new ones to fill gaps.

The moon was observed on 126 nights; the average correction required to the Nautical Almanac value of the longitude is 13·38″. After the end of 1922 Brown's tables will be used in the Almanac, and there will be a discontinuity in the errors.

Eighteen consecutive divisions of the transit circle, covering an arc of 1½°, have been obliterated from some unknown cause in recent years; new divisions have recently been cut with a small steel scriber that was screwed to the bracket holding the pointer. The new divisions are very sharp, and the errors of graduation are very small.

The distribution of temperature in the neighbourhood of the instrument has been studied; thermometers are now read outside both the north and the south walls of the observing room; they frequently show differences of some degrees, depending apparently on the direction of the wind; it is therefore somewhat difficult to know what temperature should be employed when computing refraction.

The recently published volumes dealing with the results of the observations made with the Cookson floating telescope between 1911 and 1918, and with the observations and orbits of the double stars observed with the 28-inch refractor since 1892, have already been noticed in NATURE. The latter observations are being continued, 253 pairs having been measured during the year, of which 56 had separations less than 0·5″.

The Thompson equatorial has been used, as before, for the photographic determination of stellar parallaxes. In all, 896 plates have been measured during the year, and the parallaxes of 48 stars deduced, with a mean probable error of 0·009″; altogether 142 parallaxes have now been determined with this instrument.

The 30-inch reflector has been used for a photographic determination of the wave-lengths of maximum photographic intensity in stars of different colours. A grating of steel wire, 1·42 mm. in diameter, was used to produce diffraction images, the effective wave-length being found from the separation of images; the results, which were communicated to the Royal Astronomical Society, indicate that the graph connecting wave-length with spectral type is distinctly non-linear. An extension of this work, suggested by Prof. T. R. Merton, is now being commenced. A 7-inch prism has been borrowed from the joint permanent Eclipse Committee; this will be mounted in front of the 6-inch Franklin-Adams lens, for which an aluminium camera has been made; a coarse wire-grating will be placed in front of the prism.

The astrographic equatorial was used to complete the magnitude determination of stars in the Harvard polar sequence. The results, which are in good accord with those obtained at Mt. Wilson, were published in the Mon. Not. R.A.S. of last November. The instrument has now been taken to Christmas Island for the eclipse of next September. The latest report stated that the mounting had been set up, except part of the driving clock. It has been arranged to take photographs of the Kapteyn areas in zones 15° N., 15° S., and 30° S. in order to connect the northern and southern magnitude scales.

Sunspot activity declined considerably during the year; there were, however, some prominent groups, of which the largest two crossed the central meridian on 1921, May 14, and 1922, March 2.

The mean values of the magnetic elements for 1921 and the three previous years were as follows:

	Dec. W.	Hor. Force. (C.G.S. Units.)	Vert. Force. (C.G.S. Units.)	Dip.
1918	14° 27·8′	0·18464	0·43247	66° 52·8′
1919	18·2′	0·18454	0·43242	53·3′
1920	8·6′	0·18456	0·43192	51·8′
1921	13° 57·6′	0·18449	0·43183*	52·0*

* Denotes that these values are provisional.

The mean temperature for the year ended on April 30 was 50·9° F., or 1·4° above the average. October was 6·3° above the average, the warmest October for 80 years. The rainfall was 16·49 in., or 7·75 in. below the average.

Wireless time signals from Eiffel Tower, Nauen, Bordeaux, Lyons, and Moscow are recorded on a syphon recorder; a special series of rhythmic signals from Lyons, for longitude purposes, was observed between June 20 and July 12.

The Carnegie Trust and Scientific Research.

THE twentieth annual report (1920–21) of the Carnegie Trust for the Universities of Scotland contains several points of interest. In relation to scientific training and research there are three important matters to distinguish, namely, buildings and equipment; scholarships and fellowships; and part-time research assistants and lecturers. This last is a new feature of the research scheme and is to be commended as combining facility for research with experience in teaching.

So far there are thirteen of these combined posts in the four universities of Scotland and all in the departments of chemistry and physics. They are covered by an annual outlay of 3600*l*. Of the 14,419*l*. awarded to the four universities for research fellowships, scholarships and grants, nearly half is given to history, the remainder being fairly well distributed among the departments of physics, chemistry, natural history, and medicine. Of this sum 26 per cent. goes to St. Andrews, 16 per cent. to Glasgow, 15 per cent. to Aberdeen, and 43 per cent. to Edinburgh. Thus Edinburgh distinctly leads in research; but activity is specially noteworthy in St. Andrews, which, as regards the number of students in attendance, is much the weakest of the four.

As is natural, the conditions of tenure of scholarships and fellowships, which cannot be held with other remunerative appointments, lead to many resignations in the course of the year, so that of the sum initially awarded only a total of 8123*l*. has been expended. From the point of view of research this is to be regretted. The further development of the part-time assistantship scheme may in future supply a remedy.

Under the quinquennial distribution, the schemes of the universities and other institutes of learning include buildings, equipment, libraries, and endowments of chairs and lectureships. These require on the average 50,000*l*. per annum; and of this sum 72 per cent. is devoted to buildings. For new buildings in the Faculty of Arts and the Department of Zoology, Glasgow University has appropriated 91 per cent. of its share; and the new King's buildings for chemistry are absorbing 81 per cent. of Edinburgh's share. The ultimate influence of these developments on scientific research will no doubt be great; the more immediate effect will be a demand for increase of staff and a corresponding increased expenditure in the teaching of science.

Of the 65,000*l*. expended under what is known as Clause A, nearly 13,000*l*. is devoted directly to individual research; while of the remainder by far the greater part is being used for providing suitable laboratories, for extending libraries, for endowing chairs and lectureships, and for helping in the publication of books and memoirs, the influence of which on scientific progress cannot be over-estimated. In these respects the Carnegie Trust for the Universities of Scotland seems to be fulfilling admirably its high function in the advancement of science.

University and Educational Intelligence.

CAMBRIDGE.—Dr. Roderick, Emmanuel College, has been reappointed demonstrator in surgery, and Mr. E. A. Milne, Trinity College, has been appointed University lecturer in astrophysics. A grant of 50*l*. from the Worts Fund is to be made to Mr. J. L. Evans, St. John's College, towards the expenses of a journey to make researches on the economic conditions of south, central, and south-eastern Europe since the treaties of peace, and on the question of the protection of minorities under the various treaties in the same region.

It is proposed to confer Honorary Degrees on H.R.H. the Duke of Aosta, K.G., and on Col. Sir Gerald Lenox-Conyngham.

The Statute giving the University power to confer by diploma titles of degrees upon women students of a recognised institution has now been approved by His Majesty the King in Council. The University now has power to name the recognised institutions and to lay down the conditions under which students of these institutions may qualify for these titles. It may admit members of such institutions to instruction in the University as well as to the use of its libraries, laboratories, and museums, in such numbers and on such conditions as it may determine. It may allow past residence kept and examinations passed by students of Girton College or of Newnham College as partial or complete qualification for titles of degrees.

Thus after four years of struggle does the University yield what the supporters of women's higher education asked twenty-five years ago, and one is tempted to wonder what the next twenty-five years will bring, and how long it will be before the next step in this old controversy will be taken.

Col. Sir Gerald Lenox-Conyngham, Trinity College, has been appointed reader in geodesy, and Mr. W. Dawson, Gonville and Caius College, has been re-appointed reader in forestry. Mr. C. Fox, Christ's College, has been re-appointed principal of the Cambridge University Training College for Schoolmasters.

Sir Ernest Moir has offered to endow a prize in the Engineering Department in memory of his son, Rex Moir, Gonville and Caius College, who was killed in the war. This offer has been accepted.

EDINBURGH.—On Thursday, June 8, Prof. T. H. Morgan, professor of experimental zoology in Columbia University, New York, delivered a lecture in the Natural History Theatre of the University of Edinburgh to a large audience of the staff and students on "Old and New Ideas about Heredity." The vice-chancellor, Sir Alfred Ewing, presided. Prof. Morgan gave an account of the more recent developments of the work on inheritance in Drosophila which is being carried on in his laboratory. After showing that the facts of inheritance lead to the conclusion that the Mendelian characters are carried by the chromosomes and that the hereditary factors or genes are arranged in a linear series in each chromosome, he discussed briefly the evidence available for forming a rough estimate of the upper limits of size of the factors. At the close of the lecture the dean of the faculty of law presented Prof. Morgan to the vice-chancellor for the honorary degree of LL.D. The dean remarked that the ceremony was reminiscent of the graduation proceedings of an older time when the candidate for university honours was required to maintain against all comers a thesis upon some abstruse subject of his choice, and he thought the audience would agree that Prof. Morgan's treatment

of his subject had been such as to secure the unanimous vote that he had passed his trials *summa cum laude.* Prof. Morgan was then "capped" amid enthusiastic applause.

By the will of the late Mr. H. Musgrave, of Belfast, who died on January 2, the sum of about 50,000*l.* has been bequeathed to Queen's University, Belfast, and 2000*l.* to the Royal Academical Institution, Belfast.

The summer meeting of the Association of Science Teachers will be held at Oxford on Saturday, July 8. A business meeting will be held in the morning, and in the afternoon there will be a lecture by Mr. A. F. Walden, New College, Oxford.

It is announced in the *Chemiker Zeitung* that Dr. Fr. Quincke, director of the Rhenania, Aachen, has been appointed professor of technical chemistry at the Technische Hochschule, Hanover, in place of Prof. Ost, who has retired; and Prof. Adolf Sieverts of Greifswald has become professor of chemistry at the University of Frankfort-on-Main.

The new School of Public Health, which will be opened at Harvard University next September, is offering several fellowships of 1200 dollars each for the year 1922–23. Well-qualified students working for doctorates or wishing to do a definite piece of research will be given special consideration. Applications for these fellowships should reach the Secretary of the School of Public Health, 240 Longwood Avenue, Boston 17, Massachusetts, not later than August 1.

A far-reaching scheme for industrial training was recently adopted by the Convocation of the University of London. Put shortly, the proposal is that the University should co-operate with the City Guilds and cognate bodies in the selection of Boards dealing with their respective trades, and that these Boards should seek, among the workers themselves, shrewd men and women of intelligence, skill, and *savoir faire* to deal with apprentices, learners, and improvers, bestowing upon them a kind of parental care and watching over their health, their progress, and their interests generally; that such trainers should find a place in every workshop and in every factory, and should receive recognition at the hands of the Guilds and of the University as a reward for the fostering care extended to their pupils; that the industrial classes are well able to supply such persons, men and women, in numbers sufficient to impress their mark upon the rising generation of workers, and that such might be designated University *teachers, trainers*, or *tutors* in their special trades, receiving a diploma to that effect, while, to apt and industrious pupils, the term University *pupil, scholar*, or *student* might be accessible with a corresponding diploma or certificate. In the report of the committee which accompanies the scheme, details of the various activities of the University are given under six main headings, and the thought arises, how can the Senate bear the proposed increased burden? Convocation itself seems well fitted to bear it. Its members, collected in suitable centres, would no doubt gladly assist in so meritorious a movement if the University should see fit to delegate the working out of the proposed scheme to a strong central committee (or delegacy), giving it powers to recognise local centres and to entrust them with branch work of benefit to the community. Such a delegacy might have its headquarters at the University centre, and the Clerk of Convocation could be its mouthpiece. It should report annually (at least) to Convocation, and through Convocation to the Senate, which might give it authority to speak in the name of the University on all matters relating to the scheme.

Calendar of Industrial Pioneers.

June 17, 1881. James Starley died.—The son of a Sussex farmer, Starley, in 1846, at the age of 15, became gardener to John Penn, the marine engineer. Afterwards he was employed by a London firm of machinists, and in 1857 he brought out the "European" sewing machine; subsequently he turned his attention to bicycles at Coventry. To his perseverance and energy Coventry owes its position as the centre of the cycle-making industry. A monument was erected to him there in 1884.

June 18, 1861. Eaton Hodgkinson died.—Known for his valuable contributions to the study of the strength of materials and for his discovery of the "permanent set" and of the position of the neutral axis in beams, Hodgkinson was born near Northwich in 1789. In Manchester he received lessons from Dalton, and while assisting his mother in business began the researches which led to his co-operation with Robert Stephenson and Fairbairn on their experiments in connection with the Britannia Bridge.

June 18, 1912. Floris Osmond died.—A distinguished French metallurgist, Osmond was trained at the École Centrale des Arts et Manufactures, and among other appointments he held was that of chief chemist at Schnieder's works at Creusot. Here he began his researches into the microscopical structures of iron and steel. He left Creusot in 1884, settled in Paris, and devoted himself to research, becoming the founder of the allotropic school in metallography.

June 19, 1898. Sir James Nicholas Douglass died.—For thirty years Douglass was engineer-in-chief to Trinity House, in which post he succeeded James Walker. The Wolf lighthouse was built under his supervision during 1862–69 at a cost of 63,000*l.*; he also designed the lighthouses on the Great Basses and Little Basses, strengthened the Bishop's Rock lighthouse, and during 1878–82 constructed the new lighthouse which replaced Smeaton's tower on the Eddystone.

June 19, 1915. Benjamin Franklin Isherwood died.—Born in New York City in October 1822, Isherwood was one of the first officers in the Engineer Corps of the United States Navy. He was a pioneer in carrying out scientific trials of steam-engines, and in 1859 published his "Engineering Precedents," a valuable work dealing with the friction losses and power of steam-engines. In 1861 he was raised to the position of engineer-in-chief of the Navy, a post he held till 1869. Recognised as the greatest marine engineer America has produced, he was for many years an honorary member of the American Society of Mechanical Engineers.

June 21, 1885. Henri Tresca died.—A student of the École Polytechnique, and for a time an engineer in the public service, Tresca was principal inspector of French exhibits at the Great Exhibition of 1851. Afterwards he became a professor of the Conservatoire des Arts et Métiers and served as president of the Société des Ingénieurs Civils. His labours were of the highest importance to the industrial arts of France, and included researches on the strength of materials, the efficiency of machines, the flow of metals, and the application of motive power.

June 22, 1876. Robert Napier died.—Commencing business in Glasgow as an engineer in 1815, with a capital of 50*l.* and a staff of two apprentices, Napier became one of the leading shipbuilders on the Clyde, and ultimately employed 3000 men. Of him Rankine said: "Few, if any, did more to bring marine architecture to the degree of perfection it has reached; and by drawing students of practical engineering from all quarters his building yard became a school of instruction to the world."

E. C. S.

Societies and Academies.

LONDON.

Zoological Society, May 23.—Dr. A. Smith Woodward, vice-president, in the chair.—E. G. **Boulenger** and F. Martin **Duncan**: A cinematograph record of the life-history of the Axolotl (*Amblystoma tigrinum*).—H. N. **Hutchinson**: A model reconstruction of the marine reptile *Peloneustes philarchus*, a Pliosaur from the Oxford Clay.—Sir Sidney F. **Harmer**: On Commerson's dolphin and other species of Cephalorhynchus.—C. Forster **Cooper**: Miocene Proboscidia from Baluchistan.—R. I. **Pocock**: On the external characters of Scarturus and other jerboas compared with those of Zapus and Pedetes.

CAMBRIDGE.

Philosophical Society, May 15.—Mr. C. T. R. Wilson, vice-president, in the chair.—E. H. **Hankin**: An experimental investigation of soaring flight. If the loading (*i.e.* the weight lifted per square foot of wing area) of soaring animals is plotted against the span, a regular curve is obtained. The greater the span, the greater the loading. The flying-fish is a striking exception; the loading is more than eight times as much as it would be for a bird of similar size, and as the speed is at least equal to that of birds under similar conditions, the wings of flying-fishes are more than eight times as efficient as those of birds. A model of a fin-ray (×10) was made of wood and fixed, convex side forward, in front of the radiator of a motor. A manometer measured any pressure that might develop on the rear face of the fin-ray. When the air at the level of the fin-ray was "soarable," as shown by the behaviour of dragon-flies, a pressure of 6-10 mm. of water was obtained at the rear of the fin-ray when the motor was travelling at 30 m.p.h. Generally the pressure was greater at midday than at sunset, it was abolished by rain, and also if the fin-ray was so loosely fixed that it was thrown into vibration by the passage past it of the air. The shape of the ray was found to be of little importance—the only thing necessary being that there should be a sheltered area. Probably the whole wing of a bird might be so disposed as to give a sheltered area. Increase of the sheltered area also resulted in increase of speed. Entering into a descending current causes an increase of sheltered area, and the expected increase of speed has been observed with gulls, which indulge in true soaring flight (*i.e.* steep upward glides with the long axis of the bird inclined upward and pointed in the direction of travel) only when the bird is in a descending current of air. Inland soaring birds and dragon-flies show similar effects.—F. P. **White**: The projective generation of surfaces in space of four dimensions.—C. G. F. **James**: The analytical representation of the theory of congruences of conics.—Miss H. G. **Telling**: (*a*) The geometrical theory of the apolarity of quadric surfaces. (*b*) A set of fifteen quartic surfaces in space of four dimensions, and the application to the theory of cubic surfaces in ordinary space.—J. P. **Gabbatt**: The generalisation of the theory of the circles associated with a triangle by means of the theory of plane cubic curves.—B. M. **Wilson**: An asymptotic relation between two arithmetic sums.

PARIS.

Academy of Sciences, May 22.—M. Albin Haller in the chair.—The president announced the death of M. Laveran.—P. **Urbain** and G. **Urbain**: The extraction and purification of scandium from thorveitite of Madagascar. This mineral, which contains 42 per cent of scandium oxide, is fused with soda and the silica removed by washing. The residue, after dissolving in sulphuric acid, is treated with hydrofluoric acid, which precipitates scandium and rare earths as fluorides. The scandium is separated as acid sulphate after treating the fluorides with sulphuric acid, and further purified by conversion into the double sulphate of scandium and potassium.—J. **Costantin**: The Maltese cross shown by wood that has undergone traumatisms. An account of the methods of wounding the stems of chestnut, sycamore, and other plants for producing cross-like markings on sticks to be used as canes or umbrella sticks. A description is given of the changes produced by the wounds in the stem.—J. **Andrade**: Three classes of non-maintained vibratory movements.—S. **Sarantopoulos**: Positive increasing functions.—Th. **Varopoulos**: Some theorems of M. Borel.—R. **Nevanlinna**: The relations which exist between the order of growth of a monogenous function and the density of its zeros.—E. **Pagezy**: The best shape to give to propulsive helices.—P. **Fatou**: The movement of a planet in a resisting medium.—P. **Chofardet**: Observations of Skjellerup's comet made with the *coudé* equatorial at the Observatory of Besançon. Positions for May 19 and 20 are given. The comet was of about 12·5 magnitude, maximum size 1′, condensation uncertain.—A. **Schaumasse**: Observation of Skjellerup's comet made with the *coudé* equatorial at the Nice Observatory. Position given for May 19. The comet appeared as a diffuse nebulosity about 2′ in extent; magnitude 12, feeble condensation.—A. **Andant**: The variations of critical opalescence with the temperature and the wave-length of the incident light. Measurements were made on five liquids of high critical temperatures—ether and the acetates of methyl, ethyl, butyl, and isobutyl. The phenomena observed in the case of ether are described in detail.—E. **Bauer**: The electromagnetic field of the stationary projectories of Bohr.—A. **Frigon**: The experimental study of the energy losses in some commercial dielectrics.—E. **Berger**: The reduction of oxides by hydrogen. Previous results on the reduction of nickel oxide by the author and Sabatier and Espil have not been in agreement, and further experiments have now been carried out to study the effect on the reduction of the mode of preparation and drying of the nickel oxide. The velocity of reduction and form of the curve vary with the origin of the sample of oxide, hence the deduction of the existence of an intermediate oxide from a kink in the reduction curve is not sound.—A. **Damiens**: The "dynamic" allotropy of tellurium. Cöhen and Kröner have applied to tellurium a theory of allotropy termed "dynamic," according to which any homogeneous phase of a given body may be composed of several species of molecules in equilibrium. Experiments by the author on carefully purified tellurium, crystallised, fused, and distilled, do not confirm the views of Cohen and Kröner, and all the phenomena observed can be easily explained without the formulation of a new theory.—A. **Dauvillier**: The L series of lutecium and of ytterbium and the identification of celtium with the element of atomic number 72.—G. **Urbain**: The atomic numbers of neo-ytterbium, lutecium, and celtium. From the high-frequency spectra it is now possible to attribute without ambiguity the atomic numbers of neo-ytterbium (70), lutecium (71), and celtium (72). A translation of the paper appears on p. 781.—A. **Boutaric** and M. **Vuillaume**: The flocculation of colloidal sulphide of arsenic. The influence of the concentration of the colloid, of agitation, and of temperature. The experimental

results are shown graphically in four curves.—MM. **Clément** and **Rivière**: Attempts at the synthetic manufacture of mother-of-pearl by the production of chemical systems.—A. A. **Guntz**: Phosphorescent zinc sulphide. The crystalline structure of sulphide of zinc appears to play an important part in the phenomena of phosphorescence, as shown by the different duration of the luminosity of the two varieties and by the known fact that their pulverisation suppresses almost entirely the luminous emission.—A. **Job** and R. **Reich**: An attempt at the systematic extension of the preparation of organo-metallic compounds. Application to iron ethyl iodide. Organo-zinc compounds possess the advantage over the corresponding magnesium compounds that a large range of solvents can be used. The iron derivative, C_2H_5FeI, is made by the interaction of an ether solution of ferrous iodide with zinc ethyl iodide also in ethereal solution. The new iron compound was not isolated, but its existence in the solution was proved by its reactions with water and alcohol.—M. **Flajolet**: The perturbations of the magnetic declination at Lyons during the year 1920–1921.—A. **Petit**: The harmful action of farmyard manure.—A. **Policard** and Mlle. J. **Tritchkovitch**: The direct fixation of fats by the sebaceous glands. The fat absorptions were followed by the addition of Soudan red (Daddi) to the food. The mechanism of the sebaceous glands appears to act in two waves. In the first, the classical theory, the fat is elaborated by the cell, but side by side with this there is a direct fixation of the fat brought by the blood.—P. **Portier** and M. **Duval**: The variation of the osmotic pressure of the blood of the freshwater teleostean fishes under the influence of the increased salinity of the surrounding water. The fish is incapable of maintaining a constant osmotic pressure like a mammal or a bird, but there is a clear tendency towards regulation in the carp, in which the osmotic pressure of the blood increases with an increase in the proportion of salts in the water in which it is placed.—H. **Cardot** and H. **Laugier**: The linguo-maxillary reflex.—G. **Bidou**: An orientation compass for the foot.—C. **Vaney** and J. **Pelosse**: Relations between the blood and the coloration of the cocoon in *Bombyx mori*.—E. **Fauré-Fremiet** and Mlle. H. **Garrault**: Constitution of the egg of the trout, *Trutta fario*.—A. **Helbronner** and W. **Rudolfs**: The attack of minerals by bacteria. The oxidation of blende. Certain bacteria are capable of converting blende into zinc sulphate: in minerals containing the sulphides of both zinc and lead, the lead is not attacked and only the zinc is rendered soluble.—L. **Fournier**, C. **Levaditi**, A. **Navarro-Martin**, and A. **Schwartz**: The preventive action in syphilis of the acetyl derivative of oxyaminophenylarsinic acid (sodium salt). Proofs of the prophylactic and preventive action of this salt against syphilis are given. The experiments were made both on animals and on man.

Official Publications Received.

Madras Fisheries Department. The Common Molluscs of South India. By James Hornell. (Report No. 6 of 1921. Madras Fisheries Bulletin, Vol. 14.) Pp. 97-215. (Madras: Government Press.) 1 rupee.

Agricultural Research Institute, Pusa. Bulletin No. 125: The Weevil Fauna of South India, with special reference to Species of Economic Importance. By T. V. Ramakrishna Ayyar. Pp. 21+20 plates. (Calcutta: Government Printing Office.) 1.4 rupees.

Agricultural Research Institute, Pusa. Bulletin No. 126: Cawnpore-American Cotton, II. Further Field Trials (1918–1920), Spinning Trials and Market Organization. By B. C. Burt. Pp. 13. (Calcutta: Government Printing Office.) 4 annas.

Agricultural Research Institute, Pusa. Bulletin No. 127: The Coconut-Bleeding Disease. By S. Sundararaman. Pp. 8+6 plates. (Calcutta: Government Printing Office.) 8 annas.

Department of the Interior: Canada. Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 2, No. 1: The Radial Velocities of 594 Stars. By J. S. Plaskett and others. Pp. 127. (Ottawa: Government Printing Bureau.)

Department of Agriculture and Natural Resources: Weather Bureau. Annual Report of the Weather Bureau for the Year 1918. Part 3: Meteorological Observations made at the Secondary Stations during the Calendar Year 1918. Pp. 353. (Manila: Bureau of Printing.)

Diary of Societies.

FRIDAY, JUNE 16.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—A. C. Braham: The Final Support in Carbon Printing.

TUESDAY, JUNE 20.

INSTITUTION OF GAS ENGINEERS (Annual General Meeting) (at Institution of Electrical Engineers), at 10 A.M. and 3.—T. Hardie: Presidential Address.—Gas Investigation Committee: Research on Aeration in Atmospheric Burners.—Seventh Report of the Gas Investigation Committee: Carburetted Water Gas Plant with Waste-heat Boiler.—Report of Institution Gas Research Fellowship: Dr. A. C. Monkhouse and Prof. J. W. Cobb: The Liberation of Nitrogen and Sulphur from Coal and Coke as Ammonia.—Report of the Life of Gas Meters Committee.—Report of Refractory Materials Research Committee.—A. T. Green: The Thermal Conductivity of Refractories at High Temperatures.—Miss D. A. Jones: The Standardisation of the After Contraction Test.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. Gordon Holmes: The Symptoms of Cerebellar Disease and their Interpretation (Croonian Lectures) (4).

ROYAL STATISTICAL SOCIETY, at 5.15.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—E. Peake: The Norwich School of Painters.

WEDNESDAY, JUNE 21.

INSTITUTION OF GAS ENGINEERS (at Institution of Electrical Engineers), at 10 A.M. and 3.—Dr. C. Carpenter: Some Gas Burners and a Moral.—Dr. G. Weyman: Increasing the Rate of Carbonisation of Coal.—W. B. Leech: Reconstruction Work at Beckton.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 5.—W. H. Bidlake: The Continuity of English Architecture.

ROYAL METEOROLOGICAL SOCIETY, at 5.—J. E. Clark, H. B. Adames, and A. D. Margery: Report on the Phenological Observations for 1921.—L. S. Richardson, Dr. A. Wagner, and R. Dietzius: An Observational Test of the Geostropic Approximation in the Stratosphere.

ROYAL MICROSCOPICAL SOCIETY, at 8.—A. Chaston Chapman: The Use of the Microscope in the Brewing Industry.—A. B. Klugh: The Plunger-Pipette.—E. A. Spaul: The Gametogenesis of *Nepa cinerea* (Water Scorpion).—J. Strachan: The Microscope in Paper Making.

THURSDAY, JUNE 22.

INSTITUTION OF GAS ENGINEERS (at Institution of Electrical Engineers), at 10 A.M.—Prof. C. V. Boys: A Recording and Integrating Gas Calorimeter.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—G. I. Taylor: The Motion of a Sphere in a Rotating Liquid.—Prof. T. R. Merton and D. N. Harrison: Errors arising in the Measurement of Unsymmetrical Spectrum Lines.—Dr. E. F. Armstrong and Dr. T. P. Hilditch: A Study of Catalytic Actions at Solid Surfaces. Part VIII. The Action of Sodium Carbonate in promoting the Hydrogenation of Phenol. Part IX. The Action of Copper in promoting the Activity of Nickel Catalyst.—E. A. Milne: Radiative Equilibrium: The Relation between the Spectral Energy Curve of a Star and the Law of Darkening of the Disc towards the Limb, with Special Reference to the Effects of Scattering and the Solar Spectrum.—C. W. Hinshelwood: The Structure and Chemical Activity of Copper Films and the Colour Changes accompanying their Oxidation.—R. C. Ray: Heat of Crystallisation of Quartz.

MALTHUSIAN LEAGUE (at Kensington Town Hall), at 8.—Miss Cicely Hamilton, Mrs. Seaton-Tiedeman, B. Dunlop, and Rev. G. Lang: Birth Control the Workers' Charter.

FRIDAY, JUNE 23.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—J. W. Fisher: An Experiment on Molecular Gyrostatic Action.—Prof. A. O. Rankine and C. J. Smith: The Viscous Properties and Molecular Dimensions of Silicane.—W. N. Bond: The Pressure-Gradient in Liquids flowing through Cones.—Dr. E. E. Fournier d'Albe: Demonstration of a Mercury-Drop Method of producing Visual Effects by Means of Sound.

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

TUESDAY, JUNE 20.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: The Idea of Value in the History of Philosophy (1).

WEDNESDAY, JUNE 21.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. A. A. Hijmans van den Bergh: The Pathology of Hæmoglobin. (In English.)

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The Influence of Science.

THE great advances of science in recent times, and the countless applications of its discoveries, have led many people to regard it as concerned only with purely materialistic things, and to forget its moral and intellectual influence. In their view science is associated with the transformation of beautiful countrysides into the slums of industrial centres, with high-explosive shells and clouds of poison gas to supersede the slings and arrows of earlier days. Nothing could be further from the truth, however, than to suppose that these debasing aspects of modern civilisation are necessary consequences of scientific progress. They are due to human greed and the same spirit of jealousy as that which led Cain to rise up and slay his brother. They are consequences of the fact that civilised man is little removed from a savage when his primitive instincts are concerned; and if he can acquire the strength of a giant from science he is prepared to use the power for his own purposes.

Science as such has nothing to do with the conquests of nations or peoples, or the upholding of dynasties, or industrial exploration. The end of all scientific investigation is the discovery of truth in the realm of animate and inanimate Nature, including man, his instincts and impulses and his social organisation. As expressed in the motto of the Royal Society, science is not bound by the words of any master, and it therefore holds itself free to examine critically any principle or doctrine in which natural facts or phenomena are involved. It represents knowledge as opposed to ignorance, light as against darkness, the beauty of truth and the truth of beauty. It seeks justification not through faith but by works, and its allegiance is to truth alone so far as human intelligence can comprehend it at any epoch. To this spirit is due not only advances by which forces of Nature are used and controlled for the benefit of man, but also intellectual expansion and the elevation of the moral sense through the understanding of the significance of natural law in determining natural events.

The influence of science upon material progress and human comfort is understood much more commonly than that of its effect upon the human mind. It is difficult for people of these times to realise the liberation of life and intellect brought about by the works of Copernicus, Galileo, Vesalius, and other pioneers of scientific learning. The very foundations of belief were shaken when the earth was removed from the position in which presumptuous man had placed it, and shown to be a minor member of a group of planets revolving round a sun which was itself only one of innumerable similar orbs in stellar space. For

holding this view, and also for describing spots observed by him on the sun, Galileo was denounced to the Holy Office in 1615, and when before the Inquisition in 1633 his condemnation by the Cardinals of the Holy Roman Church contained the words: "The proposition that the sun is the centre of the world and immovable from its place is absurd, philosophically false, and formally heretical, because it is expressly contrary to Holy Scripture. The proposition that the earth is not the centre of the world, nor immovable, but that it moves, and also with a diurnal motion, is also absurd, philosophically false, and theologically considered, at least erroneous in faith." Wherefore Galileo was imprisoned, ordered for three years to recite once a week the seven penitential Psalms, and made to swear, "I abjure, curse, and detest the said errors and heresies, and generally every other error and sect contrary to the Holy Church; and I swear that I will nevermore in future say or assert anything verbally, or in writing, which may give rise to a similar suspicion of me."

As one of his biographers has said, Galileo, like Peter, surrounded by a crowd of enemies, denied his Master; yet for more than fifty years he was the knight-militant of science, a rebel against the dead hand of tradition and authority, whether of priest or philosopher, when it was used to prevent the growth of knowledge through the evidence of the senses. For more than a thousand years the mind of man had been constrained by monkish theology and Aristotelian philosophy, and all attempts at freedom of thought were rigidly suppressed. The Holy Scriptures, together with the works of early Christian fathers and some Greek philosophers, were believed to contain the truth about all things—visible or invisible—and men used them as the final court of appeal as to what was true in Nature. When Galileo discovered the four satellites of Jupiter by means of his small telescope, the philosophers of his time would not look through the instrument to see the objects for themselves, for, as Galileo remarked, "These people believe there is no truth to seek in Nature, but only in the comparison of texts." They held that the moon was perfectly spherical and absolutely smooth, and it was in vain that Galileo appealed to the evidence of observation to the contrary: the sun was supposed to be immaculate, therefore Galileo's observations of spots upon it were illusions: two unequal masses dropped from the leaning tower of Pisa reached the base together, "Yet," he says, "the Aristotelians, who with their own eyes saw the unequal weights strike the ground at the same instant, ascribed the effect to some unknown cause, and preferred the decision of their master to that of Nature herself."

The principles of self-determination and self-government have been responsible since the Armistice for many political changes, but these are as nothing compared with the social effects of the independence of scientific inquiry typified by Galileo's life and work. The right of a man to think for himself was established, and personal observation and experiment took the place of metaphysical and philosophic speculation and dogmatic assertion. The freedom of thought and action now possessed by progressive peoples are direct consequences of the work of Galileo and other scientific pioneers.

Consider the tremendous revolution involved in the substitution of permanent natural law for the conception of a world in which all events were believed to be reflections of the moods of a benign or angry God. The doctrine of daily supernatural intervention meant that men regarded themselves merely as clay in the hands of the potter and did nothing to shape their own natural destiny. They accepted disease as an act of God instead of cleansing their houses, and believed that all the qualities they possessed, as well as the actions they took, were determined by the positions of the planets and other celestial bodies. Every organ of the human body was supposed to have its counterpart in the sky; and when Vesalius by his dissections and Copernicus by his doctrine showed that there was no relationship between the human frame and the order of the universe, the ponderous superstructure of faith and pseudo-philosophy which had been built upon it fell to pieces, and a new mental world had to be reconstructed. Instead of a few thousand stars supposed to exist to influence the earth and affect the purposes of man, we now know there are millions which can never be seen without telescopic aid and millions more that are not visible with any optical means. The universe has been increased ten-thousandfold, and the puerile ideas of three centuries ago have given place to a far nobler conception of the majesty of the universe and the power of the Creator.

The intellectual expansion thus brought about, together with the sense of justice which resulted from the knowledge of the existence and permanence of law in Nature, profoundly influenced human thought and resulted in social changes which had the greatest civilising effects. This end was not attained, however, without sacrifice. The medieval lover of science was obliged to pursue his researches in secret cells and hide his discoveries from all eyes. He was for ever haunted by the maddening vision of the stake. Human nature does not encourage ideas which shatter cherished convictions; and it is usually suspicious of all new knowledge. To probe into truth or try to lift the veil and expose eternal verities was, therefore, regarded as sacrilege by guardians of traditional faith or learning. Our first parents lost Eden because they partook of

the tree of knowledge; and it was by like association with the devil that Faust secured the knowledge of renewed youth.

This view of science is not altogether unknown even in our own times. There are still heresy hunters who, with their own literal interpretation of Biblical writ, seek to extinguish the light of new knowledge. If Darwin and Huxley had lived in the time of Bruno and Galileo they would have suffered like penalties for presenting evidence of man's relationship to other primates. Leaders of the Church now accept the principles of organic evolution, just as there is now an observatory at the Vatican, and active astronomical observers among the brothers and fathers of Catholic priesthood. The truth is great and prevails in the end. Scientific inquiry never ceases and must continually be a disturbing influence. It is applied to all occurrences in which natural facts and phenomena are concerned, and believes nothing without evidence. Science does not set out to establish or depose any particular articles of faith, but to examine critically whatever comes before it in the natural world and to testify faithfully to what is seen. The knowledge thus gained may at times appear to undermine the foundations of faith, but in the course of years there is a readjustment of mental values, in which old errors are lost. From a scientific point of view, a distinction must be made between religion as an essential human instinct and outworn theological creeds or formulæ which assert that belief in unnatural occurrences is necessary for spiritual salvation. It is because of the influence of science that the Dean of St. Paul's can now say publicly, "the materialistic view of the resurrection has never been universally held; it was denied by Origen, the ablest theologian of the third century, and no intelligent man believes it now."

Examination of evidence in the critical spirit of scientific inquiry is responsible for the change of attitude towards scriptural records of natural events and phenomena represented in this remark of Dean Inge's. Only those who remember the contumely to which Huxley and Tyndall were exposed because of their extension of scientific reason to theological fields can appreciate the revolutionary change which has occurred since their day and generation. The great controversy between the evolutionists and the creationists in the second half of the nineteenth century corresponded closely with that between the Copernicans and Ptolemaists three hundred years earlier, and in each case belief had to give place eventually to ascertained knowledge. It is the duty of science to continue to fight ignorance and all that is implied by it, to be intolerant of all that is false, to make honest doubt a virtue, and condemn credulity as an intellectual crime. We may not be more superstitious than our fathers, but the vestiges of primitive man still remain in our natures ready to throw up offshoots under emotional stimulation. Much that passes under the name of spiritualism comes within this category, and when the manifestations enter the domain of matter and energy, the methods by which they must be investigated are those of physical science—critical observation, dispassionate examination of results, and crucial test of conclusions. These are the methods by which science has become synonymous with accurate knowledge, and has led the world into the way of truth. In the present epoch of social and spiritual reconstruction, the active ministry of scientific truth is again needed to help the world to adjust itself to the new conditions which knowledge has created.

Medieval Cartography.

Legendary Islands of the Atlantic: A Study in Medieval Geography. By William H. Babcock. (American Geographical Society, Research Series, No. 8.) Pp. v+196. (New York: American Geographical Society, 1922.) n.p.

THE migration of man across the ocean has differed considerably from his movement overland. On one hand, he has succeeded in taming animals by way of improving on the exertion of his own muscular effort, and in consequence he has perforce followed natural routes determined in part by a minimum of physical obstacles and a maximum or, at any rate, sufficient food supply for his animals, Moreover, through carelessness or accident he has dropped implements or weapons which give clues to the routes he followed and the sites of his settlements. On the other hand, the passage of the sea has called forth a different effort in the art of shipbuilding and seamanship, and the hungry ocean has swallowed up the remains of many a goodly ship which, through storm or adventure, passed over the trackless deep. Moreover, the wanderings of a people leave deeper marks on the historical record than the deeds of the men to whose individual prowess the opening of the sea-ways was largely due.

The author of "Legendary Islands of the Atlantic" attempts to sift legend from fact and vision from observation, in islands depicted on medieval maps of the North Atlantic, and to obtain thereby the links in the story of Atlantic exploration. Yarns of the western sea no doubt became the stock-in-trade of mariners and enabled cartographers to fill with shoals and islands the blank of the Sea of Darkness. Though more recent observations have shown that many of

the islands do not exist as charted, the author establishes his reason for regarding them as indicative of early ocean voyages.

Europe and the North Atlantic are complementary, perhaps even supplementary, in their influence on the migration of peoples westward to populate a New World with the race stocks of the Old. Both the northern and southern seas emphasising the peninsular character of Europe are themselves the nurseries of boatmen, and with their special archipelagoes have invited and facilitated, from before the dim dawn of history, the maritime adventures which in succeeding ages led men to pass beyond the limits of the mainland to the oceanic islands, ever gazing towards the setting sun and wondering on the hidden mystery of the western horizon.

The physical form and phenomena of the ocean have not changed essentially since the dawn of history. Roughly circular in shape, the northern arc from the seas of north-west Europe to the entrance of the St. Lawrence is marked out by the island stations of the Shetlands, Faroes, Iceland, Greenland, Labrador, and Newfoundland. The southern arc swinging between the western coast of Africa with the island groups of Madeira, the Canaries and Cape Verde, and the eastern trend of South America with Trinidad and the Antilles, is emphasised in the intervening regions by prevailing Trades and equatorial currents.

It is therefore not surprising that reasonably accurate knowledge is shown of the various island groups that form the thresholds of the North Atlantic from the Mediterranean and the Northern Seas respectively. But within the central region of southern weed and northern storm and fog, and towards the west, casual, and it may be involuntary, voyages might be made. Here deceptive phenomena, begotten in part by unusual scenes and in part by fear and presentiment, or by stress and hunger, caused mythical and legendary islands to appear, with perhaps Rokel Rock or the Azores as nuclei, and produced enigmas for solution by later cartographical students.

We need not stay with Babcock's treatment of Atlantis. Few will disagree with his finding that every solution of the problem must be conjectural, and many will urge the same conclusions against the other islands upon which the author bases his arguments for the discovery of America in pre-Columbian times. Legendary islands, such as Brazil and Antillia, are not always located in the same regions of the Atlantic, but, like archæological remains, lie scattered over the map. It would have been extremely valuable if the author had plotted as accurately as possible on a modern map the various sites of some of these islands.

On many maps, of which the Catalan map of 1375 is a type, Brazil is shown as an annular island with numerous islets within. This, it is contended, represents the pear-shaped Gulf of St. Lawrence with its containing islands. Reference is made to the Sylvanus map of 1511 in support of this contention.

"Nobody doubts that it [the Sylvanus map] illustrates the St. Lawrence Gulf region, though there has been much speculation as to what unknown explorer has had his discoveries commemorated here, thirteen years before the first voyage of Cartier. Why should not a like episode of discovery and imperfect record have happened at a still earlier date?" (p. 65).

Antillia and its related islands as they appear on the Beccario Map (1435), the Pareto Map (1455), and others, are considered by Babcock to be the islands hitherto regarded as the special discovery of Columbus and his companions.

"There are two names still in common use for American regions which long ante-date Columbus, and most likely commemorate achievements of earlier explorers. They are Brazil and the Antilles. The former is earlier on the maps and records; but the case for Antillia as an American pre-Columbian map item is in some respects less complex and more obvious" (p. 144). "Surely some mariner had visited Cuba and some of its neighbours before 1435";

and again:

"We may be reasonably confident that Antillia of 1435 was really, as now, the Queen of the Antilles."

There is little record but the maps, and it is extremely difficult to determine whether these cartographical approximations are intelligent anticipations or based on experience. The Laurentian portolan (1351) with its broad sweep of Guinea and the distinctly non-Ptolemaic conception of South Africa, Schöner's globe (1515) with its Atlantic-Pacific passage, may with Brazil and Antillia fall into that voluminous class of verbal and cartographical descriptions from Homer until modern times which suggest that all recorded voyages and journeys are the outcome of innumerable "feelers," the experiences of the many upon which the triumphal entry of the discoverer is made.

The contention that these fourteenth- and fifteenth-century maps record adventures and voyages in western waters reopens in a new form the question of the trans-Atlantic voyages of Columbus and of Cabot, and it is to be regretted that Babcock merely mentions in passing the researches of Vignaud, and omits altogether the contention of Biggar for the second Cabot voyage.

The study of Greenland on the maps is somewhat inadequately dealt with, and students of these early maps would have welcomed a chapter on the relations and adjustment of the names of areas carrying such titles as Norbergia, Engronelant, Labrador, Bacallaos, etc., as shown on the Pilestrina map (1503–5) and others of a slightly later date.

The author deals with many other legendary islands, such as St. Brendan, Mayda, and Buss, the last two surviving until the opening of the nineteenth century, while the chapter on Markland reviews briefly the alleged discoveries of the Norse.

The book contains an excellent selection of reproductions and is welcomed as a contribution to the study of early cartographical efforts and their value in unfolding the story of geographical discovery.

W. H. BARKER.

Pasteur's Scientific Career.

Pasteur and his Work. By L. Descour. Translated from the French by A. F. and Dr. B. H. Wedd. Pp. 256. (London: T. Fisher Unwin, Ltd., 1922.) 15*s*. net.

BY the translation of this work Drs. A. F. and B. H. Wedd have made available to the English-speaking public one of the most complete accounts of the scientific career of Pasteur. Even the lay mind will be able to follow step by step and appreciate the series of brilliant researches which gave birth to the science of microbiology, culminating in that triumph of applied science—anti-rabies inoculation. Perhaps the very detail in virtue of which this book will appeal to those actively interested in science, will act as a deterrent to the general reading public. The first two chapters in particular, dealing with Pasteur's work on crystallography, require a degree of concentration likely to scare away all but the more determined. However, in a footnote we are told that these two chapters may be omitted without detracting in any way from the value of what is to follow. This is in fact correct, for these researches, although of great interest and of fundamental importance, serve mainly to show us that Pasteur, despite his unpromising years at school and the lycée, was possessed of a scientific mind which even at this early age bore the stamp of genius. They do not form a consecutive part of the brilliant investigations which follow and they can well be passed over.

The landmarks in the scientific career of this great man are familiar to most, and it would be out of place here to deal with them in any detail. Suffice it to say that in the first ten chapters or so we are given an account of his researches on fermentation, the question of spontaneous generation, putrefaction, aerobiosis and anaerobiosis. Here also an account is given of his study of diseases of wine and beer. Although perhaps less dazzling than his subsequent researches in the realms of animal pathology, this early work of Pasteur is the more interesting in virtue of its fundamental value. These are the foundations on which has been erected the edifice of microbiology. Without the knowledge gained by this work he would not have been able successfully to attack those future problems the solution of which obtained for him undying fame.

The remaining two-thirds of the book are concerned chiefly with his investigation of disease; diseases of silkworms, anthrax, furunculosis and puerperal septicæmia, chicken cholera, swine erysipelas, and finally rabies. Every one of these chapters is enthralling, but perhaps it is the study of chicken cholera which is of the greatest interest. Although his discoveries in this case did not lead to any practical application of great import, it was during these studies that a chance observation paved the way to protective inoculations. He had isolated the causal organism of this disease and shown that it was pathogenic for hens. Returning to his laboratory after vacation and wishing to continue his studies, he inoculated some hens with his cultures. To his surprise the birds remained perfectly well; his cultures had become avirulent. A fresh strain was isolated, and what was still more surprising, the hens which had received the avirulent culture were found now to be resistant to the new strain which control experiments showed to be virulent. Here was the starting-point of his work on virus vaccine and protective inoculation.

It is perhaps unavoidable that in a book of this nature one reads little of the man himself. However, one does catch a glimpse here and there. A man of great single-mindedness and power of concentration, he had a love of honesty which served him well throughout his work. His mind was of the well-ordered, clear, logical type which has characterised French science. These qualities bred in him a positive contempt for anything slipshod or ill-reasoned in experimental work, and when occasion called for criticism of work of this nature, Pasteur did so with a force and vehemence which showed little consideration for personal feelings. It was, however, nothing mean or little in his make-up which led him to do this, but merely anger at what he considered unpardonable blunders. He was not of those who suffer fools gladly. One is given an insight also into Pasteur's attitude to religion. Despite his success in the probing of nature's secrets, he retained unshaken to the end the faith given him by his parents. The following words taken from his speech on the occasion of his reception at the Académie Française reveal this side of Pasteur's character: "The greatness of human action is measured by the motives which inspire them. Happy are those who carry with them a God, an ideal of beauty which they obey: the ideal of art, the ideal of science, the ideal of country, the Gospel idea of virtue. Those are the living sources of

great thoughts and great actions. All are lit by the reflections of the infinite."

The translators are to be congratulated. Their task was by no means easy, but they have accomplished it in an eminently successful manner.

S. P. B.

History of Organic Chemistry.

Geschichte der organischen Chemie. Von Carl Graebe. Erster Band. Pp. x+406. (Berlin: Julius Springer, 1920.) England, 84 m.; Germany, 28 m.

THE history of a science has often been compared to the erection stone by stone of some great edifice; but it appears to the writer that the metaphor is ill chosen inasmuch as the complete building is already planned when the foundation is laid. A closer analogy is that of a jig-saw puzzle in which the separate, irregular bits are slowly fitted into their several places whilst the ultimate result remains hidden until the whole is complete.

This is certainly true of organic chemistry, and although the general plan seems to be taking shape in a marvellous fashion, who would declare the puzzle to be near completion or attempt to forecast its final development? Looking now at the ordered arrangement of its several parts it is difficult for some of us to realise the difficulties of the early investigators, who had to make a selection from an ever-increasing mass of disconnected observations and laboriously to piece them together. It is perhaps one of the remarkable facts in the history of organic chemistry that from the publication in 1832 of the classical research of Liebig and Wöhler on "the radical of benzoic acid," which Berzelius greeted as proclaiming the dawn of a new day, few revolutionary changes in fundamental principles have occurred to retard the steady growth of the science. Even the electrochemical theory, which engaged Berzelius and his opponents of the French and German laboratories in a somewhat embittered controversy, only served to stimulate research and add new facts to the science.

It is interesting to trace the many new theories which owe their inception to the study of organic chemistry. The theory of valency was developed by Frankland in studying the organo-metallic compounds; that of catalysis was formulated by Berzelius in explanation of the ether process. Isomerism was conceived by Faraday in examining the compressed hydrocarbon gases of the Portable Gas Co. The relation of vapour density to molecular weight elucidated by Gerhardt and Cannizzaro, the theory of atomic linking advanced by Kekulé and Couper; of stereoisomerism by Pasteur, van't Hoff and Le Bel, and in recent years of dynamic isomerism, enzyme action, steric hindrance and many other phenomena, which have helped to throw new light on molecular mechanics and structure, all originated with this branch of the science.

In the volume before us, which is printed in clear type, Prof. Graebe describes in considerable detail and in simple and attractive language the history of organic chemistry from 1770 to the 'eighties of last century, and tells us that arrangements have already been completed with Dr. Hoesch to carry the story forward in a second volume. In the arrangement the author has recorded the results not only of experimental and theoretical investigations but has attempted to show by quotations from the original sources the manner in which the new ideas were given to the world, while numerous, brief biographies of chemists are introduced as their names happen to occur.

The volume has evidently been prepared with parental thought and care which the author expresses by the word *Vorliebe*, a feeling which can well be understood in one who, during a long and active career, has himself played no insignificant part in the story he relates. We can cordially recommend the book to all chemists who are interested in the history of their science.

J. B. C.

Early British Botanists.

Early British Botanists and Their Gardens, based on Unpublished Writings of Goodyer, Tradescant, and Others. By R. T. Gunther. Pp. viii+417. (Oxford: Printed by the University Press, 1922.) n.p.

JOHN GOODYER, until recently known only as the contributor of rare plants to Dr. Thomas Johnson, the editor of the second edition of Gerard's "Herball" in 1633, and further commemorated by Robert Brown's orchid genus Goodyera, is the central personality in this absorbing volume.

About twelve years ago Canon Vaughan, rector of Droxford, a Hampshire village famous as the retreat of Izaak Walton when he retired from London, printed an article embodying fresh information, which was followed later by a longer notice by Dr. G. C. Druce in the Report of the Botanical Exchange Club for 1916, pp. 523-550, drawn up from papers in the library of Magdalen College, Oxford. Now, thanks to the assiduity of the author of the volume under notice, he, as librarian, has had the scattered notes arranged and bound, and from them has presented a picture of the man, which is a revelation. He is shown

as an active and accurate botanist, a successful cultivator, and generous in imparting his treasures to his friends. For instance, Willem Boel, the Frieslander, gathered seeds in Andalusia for Goodyer, Coys, and Parkinson, which were distributed to friends; again, from one tuber of the Jerusalem artichoke from Franqueville he raised "a peck of rootes wherewith I stored Hampsheire" in 1617.

Upon the death of Johnson, in 1644, Goodyer was unquestionably the foremost botanist in the kingdom, and his life overlapped the first anonymous essay of John Ray, his Cambridge flora, in 1660; but he was dead six years before Ray's "Catalogus" saw the light in 1670.

In addition to his knowledge of plants Goodyer knew enough Greek to translate the two works of Theophrastus, "De plantis" and "De causis plantarum"; of the former we have now an English version by Sir Arthur Hort in the Loeb Library, but the latter has never been printed in our language. Later, he began copying out the Greek text of the "Materia medica" of Dioscorides and to interline it with an English translation.

Nearly half of Mr. Gunther's volume is devoted to "Notes on contemporary botanists, mostly from Goodyer's Books and Papers." We thus become acquainted with his relations with other botanists, several of whom are unfamiliar, while many more are only slightly known to us, and from these pages we gain much. Among these may be mentioned William Coys of Stubbers in Essex; William How, the author of the first British flora and editor of Lobel's last issued work; John Parkinson, the last of the herbalists; the Rev. Walter Stonehouse, and William Browne of Magdalen, to whom his college probably owed the bequest by Goodyer of his books and papers, the foundation of the volume now under discussion.

The limits of this notice forbid any further dwelling on the contents of a volume of the greatest value and a treasure-house to everybody who is interested in British botany.

One unimportant error may be mentioned as occurring on page 84, namely, that of Mattioli's Commentaries on the "Materia medica" of Dioscorides: seventeen editions were said to be published; the actual number was nearly seventy, for Saccardo speaks of sixty at least, and he was not acquainted with all. But we close the volume with feelings of gratitude to the author; his zeal and devotion have added greatly to our appreciation of the Hampshire and Sussex botanist, whose record does so much to redeem the time when he lived from being considered a barren period for the science of botany.

B. D. J.

Functions of Industrial Research.

Research in Industry: The Basis of Economic Progress. By A. P. M. Fleming and J. G. Pearce. (Pitman's Industrial Administration Series.) Pp. xvi+244. (London: Sir I. Pitman and Sons, Ltd., 1922.) 10*s.* 6*d.* net.

THE case for research and education as the best means of assuring progress in industry is most ably demonstrated by Messrs. Fleming and Pearce, who are well known for their association in directing the Research Department of the Metropolitan-Vickers Electrical Co. Ltd., of Manchester. The book covers a very wide field, and should be read by all who are engaged either in scientific work or in industrial administration. The social aspects of the subject are kept well in view and the great importance which the scientific study of the human factor in industry is destined to take in the resettlement of industry is duly recognised, although the work of the Industrial Fatigue Board receives less attention than it deserves.

The various types of research laboratories and methods of research organisation, including the comparatively new co-operative method illustrated in British Research Associations, are dealt with in detail. Considerable space is devoted to the planning, equipment, and staffing of works research laboratories, and the financial aspect is dealt with more fully than in any previous publication.

An interesting chapter deals with the collection and distribution of information for research and industrial purposes. The problem of making an intelligence department of a works library efficiently productive might with advantage have been elaborated further, in view of the authors' special experience. Although there is need for greater co-ordination among the many agencies for collecting and abstracting scientific information, the necessity for its distribution to and absorption by the industries is infinitely more important. The British scientific worker is, perhaps, less thorough than his fellow-workers abroad in surveying the field of previous work on the problem he is investigating, and, indeed, excessive zeal in this direction may tend to limit originality and initiative. In industry, however, numerous examples of wasted opportunity and moribund conditions could be quoted which are due largely to ignorance of similar industrial practice in other countries. The awakening of inquisitiveness as to foreign methods of manufacture might prove the starting-point for a still greater receptivity among employers, and from this the step to a conviction of the desirability of actual original research is relatively small, as American experience has abundantly shown. Europe, in fact, in competing

for world markets, has more to fear from American receptiveness to new ideas than from any other single factor.

In this country the support of the Department of Scientific and Industrial Research in the foundation of Research Associations is already more than justified by its success in bringing together all types of employer, engaged in particular industries. Contact with outside scientific workers and their more enlightened competitors will inevitably result in a greater appreciation of the advantages of science by the majority of industrial leaders.

Finally, the authors deserve credit for their just appreciation of the special requirements of scientific workers engaged in pioneer research, and particularly of the ways in which such men may be encouraged to prepare for research as a vocation and to follow it without being repressed by works routine. The necessity for supporting pure science work for its paramount object of increasing the sum of human knowledge is strongly emphasised. The book is admirably produced and includes a 16-page bibliography, which should be of service to all interested in the subject.

R. S. H.

Our Bookshelf.

Physico-Chemical Problems relating to the Soil: a General Discussion held by the Faraday Society. (Reprinted from the Transactions of the Faraday Society, Vol. 17, Part 2, February.) Pp. iii+217-368. (London: Faraday Society, 1922.) 10*s.* 6*d.* net.

The Faraday Society is to be congratulated on the issue of this volume, reprinted from its Transactions; soil investigators in this country now have, in accessible form, a study of one important branch of work from a number of aspects. The volume contains the subject-matter of the general discussion held by the Faraday Society in 1921 on "Physico-Chemical Problems relating to the Soil." There are sixteen papers grouped in the following five sections: (1) Introduction and General Papers, (2) Soil Moisture, (3) Organic Constituents of the Soil, (4) Adsorption Phenomena, and (5) Colloidal Phenomena. The student of soils will find much of interest, not only in the papers themselves but also in the *verbatim* report of the discussion which followed.

Recent work on soils from the standpoint of physical-chemistry has followed two or three main lines, which are discussed in an introductory paper by Sir E. J. Russell. The examination of the soil solution and its relation to soils on one hand and plants on the other, has been much stimulated by the method of the freezing-point depression. American investigators have done much in this direction, and the paper by Prof. Hoagland (California) gives an interesting account of the work to date. Certain assumptions are made in applying this method to the soil solution, and the deductions which follow are discussed by B. A. Keen (Rothamsted) in the course of a paper on soil moisture. Prof. Shull (Kentucky) reviews various theories on the intake of soil solution through the osmotically active membranes of the root hairs.

The part played by colloidal material in soil naturally forms the subject of several papers. N. M. Comber (Leeds) discusses the flocculation of silt and clay on the assumption that the latter is protected by a siliceous emulsoid, and C. G. T. Morison (Oxford) reviews the theories of pan formation. Dr. Mellor (Stoke-on-Trent) deals with the plasticity of clays used in the ceramic industry. The organic matter in soil is of obvious importance in any discussion of colloidal properties. A general review is given by H. J. Page (Rothamsted), and Prof. Odén (Upsala) describes his own important investigations on humus, which have proved the existence of humic acid and shown that the hypothesis of selective adsorption is not a complete explanation of soil acidity. With regard to soil acidity itself there is one review paper by E. M. Crowther (Rothamsted), while Dr. Salisbury (London) discusses the ecological aspects.

Besides acidity, many other phenomena shown by soils have been interpreted on the basis of adsorption. E. A. Fisher (Leeds) presents an able critical review of work on absorptive processes in soils, with especial reference to inorganic substances.

Finally, there are some papers dealing with more purely physical questions. Prof. Odén gives a detailed account of his elegant method of mechanical analysis and a note on the hygroscopicity of clay, Dr. Hackett (Dublin) discusses the rate of ascent of liquids in granular media, while G. W. Robinson (Bangor) specifies certain physical properties of soil in relation to survey work.

B. A. K.

A Text-Book of Aeronautical Engineering: The Problem of Flight. By Prof. H. Chatley. Third edition, revised. Pp. xii+150. (London: C. Griffin and Co., Ltd., 1921.) 15*s.* net.

A second edition of Prof. Chatley's book appeared in 1910, and during the war, when interest in aeronautics attained great heights, this book, like many others on the subject, was bought in large numbers, thus necessitating a third edition. Not very much was known about the subject of aeronautics before the war; systematic treatises had not yet appeared, and Prof. Chatley's book achieved a deserved popularity.

Now that a third edition has been issued, claiming to be "revised," the opportunity should have been taken to make the book a more proportioned, authoritative, and modern exposition. There is scarcely room in a text-book for a detailed account of the ornithopter—not because it is *a priori* clear that one should not continue to make attempts at producing machines based on the flapping-wings principle, but because a text-book should contain what is more or less accepted: it should give a safe (not necessarily orthodox) account of the principles used in practice, with some attempt at justification.

A brief introduction on the problem of flight is followed by a useful statement of essential principles. Then comes a chapter on the propeller, treated by

rather rough-and-ready methods. Much of the chapter on the aeroplane is out of date; it is scarcely correct to say that the air-pressure results for plane surfaces can be corrected so as to apply to curved surfaces by slight charges in the constants, and in any case there are plenty of experimental data for giving a correct account of cambered wings. The chapter on the dynamics of aeroplanes is not very full, while a treatment of the parachute by means of differential equations is inserted for little reason, in a book which is not really a mathematical treatise. In addition nearly three of a total of less than 150 pages are occupied with Glaisher's analysis of the motion of the balloon—with the note that it has little practical value! After the chapter on ornithopters we get a short account of dirigibles and the bodies of aeroplanes, etc. There is also a brief account of stability.

Some of the appendices are useful, although the bibliography is disarranged. Foreign names are misspelt, *e.g.* an umlaut on the "a" in Lilienthal. The author has the ability to produce a real text-book on aeronautics, but the present volume is disappointing.

S. BRODETSKY.

Die Pendulations-Theorie. Von Prof. Dr. H. Simroth. Zweite Auflage. Pp. xvi + 598. (Berlin: Konrad Grathlein, 1914.) 13.50 marks.

FIRED by a new view of the shifting of the polar axis of the earth the speculative mind of a distinguished zoologist, Simroth, conceived the idea of a relation between earth oscillation and organic development.

The merit of this oscillation theory of organic distribution was its reduction of the rise and spread of organic forms to a single process in relation to recurring secular change. Simroth assumed that the earth forms an oscillation system of a peculiar kind, such that one maximum line of stress runs north and south through Norway, Germany, the line of elevation of the Alps, and across the western Sahara, while the other companion stress line passes through Bering Strait and the Pacific, west of the American coast. Assuming also permanence of the general configuration of the oceans and continents, Simroth then makes his grand assumption, which is that the evolution of genera has recurred along the European line of maximum oscillation (which is therefore the region of creative evolution) in response to secular changes of environment. From this area of distribution those forms that are primitive migrate eastwards or westwards to areas of less disturbance, whilst the progressive forms adapt themselves to the cold of polar uplift or the warmth of equatorial depression. In this way Simroth accounts for the occurrence of allied forms in widely separated parts of the world. Beings are what they are and where they are, as a "function" of the oscillation system.

The new edition of this work does not remove the difficulties of those who refuse to accept Simroth's hypothesis. The new matter consists merely of 33 pages appended to a reprint of the first edition and contains no references to criticisms such as those of Prof. G. C. Bourne (Proc. Zool. Soc. 1911, pp. 802-805) that refer to a fundamental objection—the secondary nature of marine organisms. If Dr. Simroth has not converted his fellow-zoologists, he is not likely to make converts in other biological fields. Granted that we have no simple alternative to his view, yet the assumptions on which it rests are not in accordance with modern geological opinion; and if that is so, biological speculation on such a weak basis is only misplaced ingenuity. The earth as a system of stresses is likely to prove a much more complex theme than the one Simroth vaguely describes, while the relation between maximum stress and biological progress requires far more critical examination than he gives to it.

F. W. G.

Swiss Travel Almanac. Edited by the Swiss Tourist Information Office. Summer Season, 1922. Pp. 112. (Olten, Switzerland: O. Walter, Ltd.; London: Swiss Federal Railways, Regent Street, 1922).

THIS book is a reminder that Switzerland is ready once more to become "the playground of Europe," and it is especially an appeal to English visitors. The numerous signed essays include one by Mr. A. Latt on "English influences on Swiss intellectual life," recalling many pleasant details of *rapprochement* in the seventeenth and eighteenth centuries. Mr. Schaederlin writes finely of the brave hardihood of alpine trees. Good and readable as the essays are, the great charm of the book lies in its illustrations. The well-known scenes of tourist gatherings are relegated to the advertisement pages at the end, and throughout this modestly styled Almanac we are given an exquisite series of photographs, printed in brown, of "trees and woodlands" in the Alps. Each of these appeals delightfully to the naturalist, who will promptly consult the calendar and the tables of exchange.

G. A. J. C.

Handbook of Commercial Information for India. By C. W. E. Cotton. Pp. viii + 383. (Calcutta: Superintendent Government Printing, India, 1919.) 1 rupee: 2*s*.

MR. COTTON'S book is a useful volume which gives in a condensed form, and well arranged for reference, notes on all the principal exports of India, including origin, district of growth, processes of preparation, and conditions of export. It does not profess to be a scientific work or in any sense a rival to larger and more complete gazetteers of Indian products. It has been compiled for traders, and with this end in view notes on ports and commercial organisations are added. Among the State departments connected with trade we find a reference to the geological survey but none to the Survey of India or to the Royal Indian Marine. Does this imply that maps and charts have no bearing on trade? It is to be hoped that the demand for this book will result in the publication of an annual edition.

Das Problem der Genesis des Actiniums. Von M. C. Neuburger. Sonderausgabe aus der *Sammlung chemischer und chemisch-technischer Vorträge.* Herausgegeben von Prof. Dr. W. Hertz. Band XXVI. Pp. iii + 64. (Stuttgart: Ferdinand Enke, 1921.) 5 marks.

THE author discusses the experimental work done on the origin and transformations of actinium, and the various hypotheses which have been put forward as to the successive changes in the actinium series. He concludes that at some stages, besides α-and β-particles, particles of mass 3 and charge 2 are emitted. There is a detailed list of references, including some so recent as the year 1921.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Continuous Radiation found in some Celestial Spectra beyond the Limit of the Balmer Series of Hydrogen.

IN the account of his observations of the eclipse of January 22, 1898, published in the Philosophical Transactions, A 197, pages 389 and 399, Mr. Evershed directed attention to a curious continuous spectrum emitted by the solar chromosphere and prominences. This spectrum begins near the limit or head of the Balmer series of hydrogen lines, and extends with gradually decreasing intensity in the direction of shorter wave-lengths. In describing the phenomenon Evershed referred to the early observation by Huggins of an absorption in the corresponding region in the spectra of Vega and other stars having especially strong hydrogen lines (stars of Class A),[1] and advanced the opinion that the spectrum, like the Balmer series which it so curiously supplements, is due to hydrogen. The grounds for this view were afterward strengthened through the discovery by Wood of a continuous spectrum occurring beyond the limit of the sodium series of dark lines, under conditions of laboratory experimentation that favoured the development of the higher members of the sodium series.[2] More recently an emission spectrum, apparently identical in character with the one observed by Evershed in the chromosphere, has been found to be characteristic of the planetary nebulæ.[3] The spectrum seems also to occur in the diffuse nebula N.G.C. 1499,[4] and has been a conspicuous feature in the radiation of the novæ. It may therefore be regarded as rather a commonplace phenomenon pertaining to the spectra of celestial objects which appear to exist under conditions of strong thermal or electrical excitation. For the purposes of this note I shall use the term *outlying spectrum* in referring to it in order to distinguish it from the general continuous spectrum of more uniform distribution which is found even in the gaseous or "bright-line" nebulæ.

The outlying spectrum, as an emission phenomenon, has not, that I am aware, been observed in the laboratory, except possibly by Dufour,[5] who found an ultra-violet continuous spectrum which, however, he associated with the *secondary* spectrum of hydrogen, and not with the Balmer series. In view of its general occurrence in a large group of extremely interesting and important celestial spectra, it would seem desirable that serious effort be directed toward its development in the laboratory, with the view of establishing the circumstances of its origin. As a preliminary step in estimating the conditions likely to prove favourable for its emission it may not be out of place to recall a theoretical explanation that has been advanced to account for it.

In a paper read two years ago before the American Philosophical Society,[6] the present writer suggested that the spectrum might be explained on the basis of the Bohr theory, as resulting from the capture of free electrons by hydrogen nuclei. Although the idea was developed from independent considerations, it cannot be regarded as an original one, since Bohr, in his first paper,[7] had suggested the reverse process to account for the sodium absorption referred to above as having been found by Wood. Inasmuch, however, as he had not applied the consideration to the explanation of an emission spectrum in that region (such as was known to exist in the spectrum of the chromosphere), it seemed appropriate at the time to direct attention to that aspect of the theory, and I venture to revert to it here, both on account of its theoretical interest, and because it may possibly prove suggestive of the conditions under which the spectrum should be sought in the laboratory.

Briefly outlined, the argument is as follows: The mechanism which Bohr sets up for the hydrogen atom is a positive nucleus surrounded by an infinite series of fixed orbits in which it is possible for an electron to revolve. A line of the Balmer series is formed when an electron "jumps" from one of the outer orbits to the second one, and the complete series of lines results from the totality of transfers or jumps from all of the outer orbits. The frequency of vibration is in each case proportional to the energy set free in the transfer from the outer to the second orbit, and the frequency at the head, or limit, therefore corresponds to the energy set free in the fall of an electron from rest at infinity. An electron with an additional velocity of its own will of course give up more energy in its capture than one starting from rest, so it will have to be manifested by a radiation of proportionately greater frequency, that is to say, of less wave-length, than that of the series limit. The exact position of the resulting line will depend upon the amount of the initial kinetic energy, and since this must, in general, vary from one electron to another, the totality of these radiations should make up a continuous spectrum beginning at the Balmer limit and extending into the ultra-violet. It is thus seen that, by this theory, the Balmer series is caused by the falling inwards of electrons forming part of the atomic system, while the outlying spectrum is due to the capture of extraneous electrons. It is scarcely necessary to point out that the reasoning applies with equal force to the Ritz and Lyman series, and to other series of like character.

Preliminary to discussing this explanation it is well to calculate the initial kinetic energy required to produce the observed spectrum. The outlying spectrum can be followed in a number of planetary nebulæ to about 3340Å. This is of course an extremely rough estimate, for the spectrum is faint, and on this side fades gradually to invisibility. The energy required to develop a line here may conveniently be expressed in terms of that needed at the Balmer limit (3646Å) as

$$365/334 \times \nu_1 h = 365/334 \times \mathrm{N}h/4,$$

where ν_1 is the frequency at the Balmer limit, N the series constant, and h is Planck's element of action. Of this energy the amount $\mathrm{N}h/4$ has been developed in capture, leaving the remainder as the original kinetic energy of the electron. Calling this $\mathrm{E}k$, we have

$$\mathrm{E}k = 31/334 \times \mathrm{N}h/4,$$

substituting the numerical values: $h = 6{\cdot}547 \times 10^{-27}$ and $\mathrm{N} = 3{\cdot}290 \times 10^{+15}$,

$$\mathrm{E}k = 5{\cdot}00 \times 10^{-13}. \quad . \quad . \quad . \quad . \quad (1)$$

This is the amount of kinetic energy which must have been possessed by the electron before coming under the action of the capturing nucleus in order that it should be able to develop a line at 3340Å.

[1] "An Atlas of Representative Stellar Spectra," p. 85. For a more complete investigation of the absorption in the Class A stars, see Hartmann, *Physik. Zeit.*, 18, 429, 1917.
[2] *Astrophys. Jour.*, 29, 100, 1909.
[3] *Lick Obs. Bull.*, 9, 54, 1917; also *Publ. Lick Obs.*, 13, 256, 1918.
[4] Hubble, *Publ. Astron. Soc. Pacific*, 32, 155, 1920.
[5] *Ann. Chim. et Phys.*, (8), 9, 361, 1906.
[6] Proc., 49, 530, 1920.
[7] *Phil. Mag.*, 26, 17, 1913.

If we regard the speed of the electron as having been acquired through intermolecular reactions making for the equipartition of energy, the above quantity should be comparable with the energy of molecular agitation. For a temperature of 1000° Abs. the mean kinetic energy of a molecule is

$$E(1000) = 2{\cdot}06 \times 10^{-13}. \quad . \quad . \quad . \ (2)$$

Comparing (1) and (2) it is apparent that a gas temperature of about 2500° will be required if an electron of average energy is to develop a line at 3340Å. That position, however, marks the extreme end of the spectrum, and radiation in the neighbourhood is therefore to be regarded as due to the capture of electrons of exceptionally high speed. According to Maxwell's law an appreciable proportion of the molecules have three or four times the mean energy, and it is therefore permissible to divide our 2500° by some such figure as that. It accordingly seems reasonable to assume that 1000° Abs. Cent., or even a less temperature, in the presence of the proper degree of ionisation, would suffice to produce the observed spectrum.[1] The temperature of the chromosphere is of course very much higher than that. With respect to the nebulæ, while we have no general knowledge of their thermal states, it will be recalled that Buisson, Fabry, and Bourget have estimated the temperature of the Orion Nebula to be of the order of 15,000° Cent.[2] In the light of such an estimate, the theoretical requirement of 1000° cannot be regarded as extravagant.

The foregoing considerations related to the suggestions that the electron acquires its speed through equipartition of molecular energy, according to the kinetic theory; that is to say, the spectrum has been regarded as a "temperature effect." It is of course quite conceivable that the electronic velocity might be acquired in some other way, for instance, through the action of an electric field, or photoelectrically, as has been suggested to me by Prof. Frederick A. Saunders in a personal letter. The presence in the Class A stars of absorption beyond the Balmer limit may be taken as evidence that photoelectric ionisation is going on in their atmospheres, and as most of the planetary nebulæ have nuclei that are powerful radiators of ultra-violet light, the suggestion is an attractive one. However, unlike the Class A stars, the nuclei show no perceptible falling off in strength near the head of the Balmer series. If absorption through photoelectric action takes place it is probably higher in the spectrum.

The above remarks refer very largely to the upper, or more refrangible limit of the outlying spectrum; of greater importance is the lower limit, since here contact is established with the line series. The spectrum fades gradually to invisibility at the upper extremity; at the lower the termination is, on the other hand, quite abrupt, and should, according to what has been said, lie at the theoretical limit of the Balmer series. As a matter of fact it has been found, I believe in every case, to be perceptibly to the redward of that point. We recall that this outlying continuous spectrum comes down to the junction from the more refrangible part of the spectrum, and the line series reaches up from the other or redward end. The series limit is at 3646Å, while the edge of the outlying spectrum in the chromosphere, according to Evershed, lies at 3668Å; that is to say, the outlying spectrum overlaps the series limit by about 22Å; more than that, it extends 7Å beyond the highest series line observed by Evershed (3661Å). In the radiation of the nebulæ the end of the outlying spectrum is difficult to measure, but it lies quite certainly to the redward of the Balmer limit. In N.G.C. 7009 it has been estimated to be at about 3650Å, in other nebulæ it is at a greater wave-length. More marked is the discrepancy for the absorption spectrum in the Class A stars. Thus in the spectrum of α Cygni the absorption spectrum may be said to begin at 3710 ± Å, and to reach full strength at 3660 ± Å,[3] while for Vega[4] the corresponding positions are 3800 ± Å and 3710 ± Å. In the latter case we have then the beginning of absorption 150Å to the redward of the series limit, a disparity between theory and observation that might raise a doubt as to whether the absorption bears in reality any relationship to the Balmer series. A consideration of the influence of density will, however, show that an inequality of that order is to be expected.

It is probably significant that in the spectra of α Cygni and of Vega the last of the recorded series lines falls in each case in the neighbourhood of the point where the outlying absorption attains its full value. Thus for Vega the series is lost at 3687Å, and the estimated position of the attainment of full absorption is 3710 ± Å; for α Cygni the highest line is 3668Å, with full absorption estimated to begin at 3660 ± Å. The estimates of the position at which full absorption begins are difficult to make, and the positions given are only roughly approximate, but it is quite evident that the series of dark lines which lie to the redward, and the continuous spectrum which extends in the other direction, merge one into the other, and that the second begins at the *actual* and not at the *theoretical* limit of the first.

The inference that the continuous spectrum should begin at the theoretical limit is based on the assumption that the atomic orbits extend to infinity. Bohr has pointed out that the size of the orbit system is necessarily limited by the density of the radiating gas, and has explained the absence of lines of a very high order as a consequence. Applying this consideration to the theory of the outlying spectrum it seems necessary to substitute for the "orbit at infinity" adopted in our former reasoning, the largest orbit in effective operation. Into the atomic system, as circumscribed by this orbit, electrons may be conceived to enter with speeds from zero upward. Now an entering electron of speed zero has less energy than one moving in the outer effective orbit—less by just the kinetic energy of orbital motion. In dropping into the second orbit therefore it sets free a smaller amount of energy, and consequently produces a line of lower frequency (or greater wave-length) than that of the series line which corresponds to the outer effective orbit. But the line formed by this electron must mark the more refrangible edge of the outlying continuous spectrum. We should, therefore, expect the continuous spectrum to begin somewhere on the less refrangible side of the highest visible member of the Balmer series. In other words, there should be an "overlapping" of the bright-line and continuous spectra such as is actually found. The margin of overlap should be proportional to the kinetic energy of the electron in the outer effective orbit, and on this assumption is expressible by the relation:

$$\nu_2 - \nu_3 = \nu_1 - \nu_2,^5 \quad . \quad . \quad . \quad . \ (3)$$

[1] A higher estimate of the required temperature was given in the earlier paper. I have not at hand the computations on which it was based, but it seems to have been affected by some numerical error, probably the use of N in place of N/4 for the coefficient of h in the equations preceding (1) of this paper.

[2] *Astrophys. Jour.*, 40, 258, 1914.

[3] *Lick Obs. Bull.*, 10, 103, Fig. 1.

[4] *Publ. Lick Obs.*, 13, 257, Fig. 2. The positions for both Vega and α Cygni are scaled from the intensity curves in the respective references. They are subject to great uncertainty. Compare stellar intensity curves by Hartmann, *Phys. Zeit.*, 18, 431.

[5] The expression follows at once from the frequency-energy relation assumed by Bohr. Let the nth be the largest effective orbit of one of his atomic systems; then for the highest line we have:

$$\nu_2 = N(1/2^2 - 1/n^2).$$

The second term in the parenthesis represents the energy lost during the

where ν_1 is the frequency at the theoretical limit of the Balmer series,
ν_2 is the frequency of the highest line that can be formed,
ν_3 is the frequency at the redward edge of the outlying spectrum.

This expression tells us that, expressed in frequencies (and the relation holds approximately for wave-lengths), the margin of overlap of the continuous and line spectra should be equal to the interval between the highest *observable* line of the Balmer series and the theoretical limit.

There are two factors tending to modify the above conclusion. One is that, by the kinetic theory, comparatively few electrons of approximately zero velocity are to be expected. Since these determine the redward edge of the outlying spectrum, that edge should be faint, and the effective limit might be of slightly less wave-length. The other is the fact that all the atomic systems will not at any one instant be reduced by molecular interference to outer orbits of exactly the same order. In these circumstances we should expect the large systems to determine the highest visible lines, and the small ones to establish the redward edge of the outlying continuous spectrum. The effect here would be to introduce a "blurring" factor, and increase the overlap. While these two factors operate against each other, it seems quite impracticable to attempt an estimate of their net effect.

To check the conclusions, the data on the emission spectrum of the chromosphere and the absorption spectra of α Cygni and Vega are collected in the accompanying table. Unfortunately the emission spectra of the nebulæ have not been measured accurately enough to establish their limits. In our theoretical discussion we have regarded the problem from the point of view of emission, and it is perhaps not entirely justifiable to check the conclusions through recourse to absorption spectra, for absorption and emission cannot, in such a case, be regarded as exactly complementary. It is necessary, however, to use the stellar spectra, since, with that of the chromosphere, they constitute the only radiations that have been sufficiently well observed.

Source.	Highest line of Balmer series. Observed.	Commencement of continuous spectrum. Observed.	Computed.
Chromosphere (em.)	3657*	3668	3668
α Cygni (abs.)	3668	3700 ±	3691
Vega (abs.)	3687	3800 ±	3729

* The most refrangible line observed by Evershed was 3661Å. Mitchell, on the occasion of the 1905 eclipse (*Astrophys. Jour.*, 38, 431, 1913: also Publ. Leander McCormick Obs., 2, 49), photographed six additional lines, the highest being at 3656.8Å, the value adopted here. Evershed's plates were taken with a prism spectrograph and Mitchell's with a grating instrument of considerably greater power. The greater extent of the latter's spectrum is no doubt due to that fact.

The last column contains the positions of the lower edge of the outlying spectrum computed from the frequencies of the highest visible lines, using equation (3). The discrepancy between the observed and derived values for Vega is rather large and undoubtedly exceeds the error of measurement. It should be remembered, however, that in the atmosphere of a star absorption must take place throughout a considerable range of density, corresponding to different levels. The higher lines of the series, on which the computations rest, probably originate in the upper and rarer atmosphere, where the conditions are favourable for their formation, while we should expect the edge of the outlying spectrum to be determined in a region of comparatively high density. This would account for a divergence such as the one shown. Considering the number of extraneous factors that have a bearing on the problem the agreement is probably as good as might be expected. The measurements show the progress of the edge of the outlying spectrum toward the redward as the higher members of the Balmer series fade out, and this is in general accord with the theoretical deductions.

transfer from infinity to the *n*th orbit. This is also equal to the kinetic energy of the electron due to motion in its orbit, so that an electron at rest at the *n*th orbit will have lost twice that amount. Therefore

$$\nu_3 = N(1/2^2 - 2/n^2).$$

Remembering that $\nu_1 = N/2^2$, the relation (3) follows.

Summary of Conclusions.—The outlying continuous spectrum found in certain celestial spectra beyond the limit of the Balmer hydrogen series is, as was suggested by Evershed, almost certainly due to hydrogen. It should be more completely studied astronomically, and serious effort should be directed toward developing it in the laboratory, on account of its theoretical interest and of its bearing on astronomical problems.

The spectrum is explicable, on the basis of the Bohr theory, as resulting from a change of state, as between a free electron and one in the second orbit. Bohr's original application of the principle to the case of absorption through photoelectric action on hydrogen atoms, is extended to the conception of emission as resulting from the capture of free electrons by hydrogen nuclei.

Theory and observation are in accord in placing the beginning of the outlying spectrum, not at the theoretical limit of the Balmer series, but to the redward of it, the amount of the displacement being greater as the number of observed series lines is less.

It seems possible to account for the spectrum on the basis of either thermal or electrical excitation. Regarded as a heat effect, it indicates for the planetary nebulæ a temperature of the order of 1000° Abs. Cent. or more. (The figure is not, however, offered as an estimate of the temperature of the nebulæ.)

W. H. WRIGHT.

Mount Hamilton, California, April 21, 1922.

Discoveries in Tropical Medicine.

I HAVE never thrown any doubt upon the influence of the suggestions made by Manson to Ross which led to the close study by Ross of the carriage of the malaria parasite (of both birds and man) by mosquitoes, and the discovery by him that mosquitoes of the kind known as Anopheles and not those of the kind known as Culex are the "intermediate hosts," in which the parasites causing malaria in man undergo necessary and remarkable stages of their development.

I was a member of the Committee of the Royal Society with which Ross was in constant communication during his work in India, and followed that work step by step in the reports sent home by him. My knowledge of the work of Laveran, of Labbé, Danilewski, and of Celli and of Grassi and the Italian school does not support the claims to "discovery" put forward on behalf of Manson by some of his friends. They are exaggerated and inaccurate—though Manson's influence and enthusiasm need no such mistaken advocacy in order to receive recognition.

It is the fact, in spite of assertions to the contrary, that Manson did *not* discover the part played by the mosquito in the transmission of *Filaria sanguinis hominis*. Important details as to the part played by the mosquito—of whatever kind—in that transmission have yet to be ascertained. They are still—at the present moment—a subject of investigation.

The kind of statement put forward in order to do honour to Manson, but really of a misleading nature, is exemplified in the following from Dr. Sambon's letter in NATURE of May 27. He writes: "Sir Ray Lankester ignores Manson's brilliant interpretation of the 'flagellating' malarial parasite, looked upon by the Italians as a form of degeneration; by Manson as the prelude to a further all-important developmental stage outside the body of man." The reader of Dr. Sambon's letter would suppose that Manson had in this matter had "a happy thought" and had put forward a successful speculation. Such is not the case. The nature and significance of the flagelliform bodies developed by the malaria parasite were first discovered by Dr. W. G. MacCallum, of the Johns Hopkins University, Baltimore, and published by him at the meeting of the British Association in Toronto, August 1897, and more fully set forth with admirable illustrations in the *Journal of Experimental Medicine*, vol. iii., 1898. He describes the rapid formation of these bodies in the Halteridium of birds (crows) as others had already done both in that case and in the malarial parasites of man. What is of capital importance in MacCallum's paper is the careful description and drawings of the active—even violent—union of the liberated flagelliform bodies with certain granular spheres or female gametes. A single flagelliform body was thus seen to fuse with one female gamete. MacCallum, having once recognised this sexual process, observed it daily, and then observed the same process in the æstivo-autumnal parasites taken from two cases of malaria in a human subject.

In discussing the significance of his discovery, MacCallum writes that the whole Italian school believed the flagelliform bodies to be due to degenerative changes. "Manson," he writes, "as is well known, has advanced the idea that the flagellate bodies represent the forms in which the parasite exists outside the human body, that the flagella penetrate from the stomach into the body of mosquitoes which have sucked the blood of infected human beings, and that, after a further unknown process of development, they come again (through the water in which the mosquitoes deposit their eggs and die) into the human body." This and other suppositions were entirely set aside by MacCallum's discovery. MacCallum insists that Manson's idea is not based on any observations, but is pure hypothesis! Manson's interpretation of the flagellating malarial parasite was, though erroneous, a legitimate hypothesis, but it certainly was not "brilliant," although we are asked by Dr. Sambon to regard it as being so. E. RAY LANKESTER.

June 5, 1922.

The Isotopes of Tin.

THE insensitivity of the photographic plate in recording positive rays when compared with its sensitivity to light has long been observed, and has been accounted for by the fact that the action of positive rays is purely a surface effect. There has, therefore, always been the hope that considerable improvement could be made in this direction by increasing the concentration of the bromide particles on the surface of the gelatine. This hope has now been realised to some extent by the use of a method which, I understand, has been devised for the production of Schumann plates. It consists essentially in dissolving off more or less of the gelatine by means of acid. I have not yet succeeded in obtaining certain or uniform effects, but in the most favourable cases the sensitivity of the "Half Tone" plates used in the mass-spectrograph has been increased ten to twenty times without seriously altering their other valuable properties.

The immediate result has been the definite proof of the complex nature of the element tin which had been previously suspected (*Phil. Mag.* xlii. p. 141, July 1921). Tin tetramethide was employed, and a group of eight lines corresponding approximately to atomic weights 116 (c), 117 (f), 118 (b), 119 (e), 120 (a), 121 (h), 122 (g), 124 (d) was definitely proved to be due to tin. This conclusion was satisfactorily confirmed by the presence of similar groups corresponding to $Sn(CH_3)$, $Sn(CH_3)_2$ and $Sn(CH_3)_3$. The intensities of the various components indicated by the letters in brackets agree quite well with the accepted chemical atomic weight 118·7, and incidentally preclude the possibility that any of the lines, with the possible exception of the extremely faint one at 121, are due to hydrides.

The spacing of these eight lines, which are only just resolved, show that their differences are integral to the highest accuracy, but the lines themselves compared with known lines on the plate give atomic weights always tending to be 2 or 3 parts in 1000 too light for the above whole numbers. That this remarkable divergence cannot be explained as experimental error is very strongly indicated by the following consideration. The discharge tube had been used previously to investigate some very pure xenon. The line due to $Sn^{120}(CH_3)$ should therefore have appeared exactly halfway between the two strong xenon lines 134, 136. It was actually quite unmistakably nearer the former, so much so that the two were only partially resolved. The same irregular grouping repeated itself in another portion of the field in the following spectrum. It seems, therefore, difficult to resist the conclusion that the isotopes of tin have atomic weights which are less than whole numbers by one-fifth to one-third of a unit of atomic weight, but satisfactory settlement of this important point will probably have to be deferred till a more accurate mass-spectrograph has been made.

Incidentally I may add that the presence of the two faint components of xenon 128 and 130 previously suspected has now been satisfactorily confirmed.

F. W. ASTON.

Cavendish Laboratory, Cambridge, June 7.

The Spiracular Muscles of Hymenoptera Aculeata.

I DESIRE to direct the attention of entomologists to a recently discovered muscle (see *Bee World*, vol. iii. p. 282, April 1922) present in the honey bee (*Apis mellifica*), and probably in many others of the Hymenoptera Aculeata.

The abdominal (respiratory) muscles of *Apis mellifica* were described by Carlet (*Comptes rendus*, Acad. Sci., Paris, 1884, vol. 98, p. 758). His list is incorrect; it misplaces the posterior attachment of the internal oblique muscle and omits the interdorsals and the spiracular muscles. To the latter it is desired to direct attention here. They run from the lateral sternal apophysis to the larger of the two cones of the spiracle on the tergum of the same segment. Thus, when the abdomen is expanded, this muscle is under tension, and will pull open the closing apparatus of the spiracle. During expiration, the abdomen is contracted; the spiracular muscles will therefore be slack during this process, and it appears highly improbable that the spiracles actuated by them can open during expiration. The expired air must therefore pass out of the system mainly through the thoracic spiracles; a fact which renders comprehensible

the immediate ill effects of blocking of the prothoracic spiracles by *Tarsonemus woodi*, the causal parasite of Isle-of-Wight (Acarine) disease.

Spiracular muscles (apparently similar in function to those of *Apis mellifica*) have been found in *Vespa sp.*, *Bombus sp.*, and a wild bee (? *Prosopis*). In a modified form, they are present in *Formica sp.*, being there apparently attached to the anterior edge of the tergum, and not to the sternal apophysis.

To see these, as well as the other abdominal muscles of the bee, I may mention that material preserved in equal parts of methylated spirit and formalin, deeply coloured with light green so as to stain the muscles, is excellent. Dissect in water.

ANNIE D. BETTS.

Hill House, Camberley, Surrey.

Symbiotic Bacteria and Phosphorescence.

IN Prof. Gamble's review of Buchner's "Tier und Pflanze in intrazellularer Symbiose" (NATURE, May 6) reference is made to the work of Pierantoni, according to whom the luminous organs of cephalopods are "essentially cultures of bacteria in media suitable for their nutrition and in situations favourable for obtaining oxygen."

The claims which are made for the existence of similar symbiotes in fire-flies and many other phosphorescent organisms may be extravagant, but Newton Harvey's recent announcement in the Year-book (No. 20 (1921), pp. 196-97) of the Carnegie Institution of Washington is exceedingly important in this connection. Harvey worked on two fishes with very large luminous organs—Photoblepharon and Anomalops—at Banda in the Dutch East Indies. He found bacteria always present in the organs, and emulsions of these organs behaved exactly like emulsions of luminous bacteria. The light continues night and day without ceasing, independently of stimulation. This is characteristic of the light due to luminous bacteria and fungi alone among organisms. Harvey did not succeed in growing the bacteria artificially, however; but considering the conditions under which they apparently live, this would, naturally, be a task of great difficulty. Dahlgren (see the same reference) seems to have confirmed Harvey's discovery in other fishes.

Luciferin and luciferase could not be demonstrated, which is also characteristic of luminous bacteria.

F. A. POTTS.

Trinity Hall, Cambridge.

Stone Preservation.

MAY I throw out a suggestion, which, I believe, is new, as to a method for preserving decaying sandstones from further decay?

Certain compounds of alcohol-radicles with silica, when exposed to moist air, hydrolyse, deposit hydrated silica in a coherent form, and thus act as a cement. The ether can be thinned with alcohol, and is a very stable body so long as it is not exposed to moisture, and if a piece of rotten sandstone is treated with it, in the course of a few days the sandstone hardens up and the resulting cement resists the attacks of acids.

Unfortunately, this process does not solve equally well the important problem of preserving limestones, since, though it binds the particles of limestones together, it does not protect the particles themselves from attack.

A. P. LAURIE.

Heriot-Watt College, Edinburgh, May 31.

Oscillation Circuits for the Determination of Di-electric Constants at Radio Frequencies.

DURING the last year or so a number of investigators have made use of the underlying principles of the heterodyne system of wireless telegraphy in the determination of di-electric constants. The extreme sensitivity of this method, and its freedom from some of the weaknesses which have rendered precise measurements by the older methods difficult of attainment, are rapidly increasing its popularity, and any changes which make for simplicity and for still greater certainty are of interest.

For no apparent reason circuits of the type used only for receiving signals have, so far as the writer is aware, been employed, though greater efficiency is to be expected from the use of a transmitting circuit in conjunction with such a receiving circuit generating local oscillations. In either case it is preferable that the oscillation circuit, of which the condenser containing the material under investigation forms a part, should not rectify, as rectification is necessarily accompanied by distortion of wave form.

Instead of using the two electrically insulated circuits hitherto employed the writer prefers that shown in Fig. 1, in which simple transmitting and receiving circuits are combined in such a way that

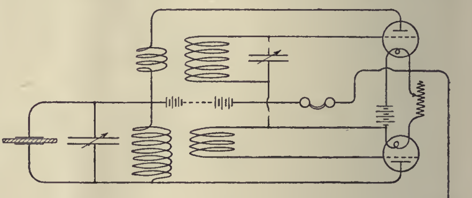

FIG. 1.

oscillations of two different frequencies can be generated although both valves are fed from the same filament-heating and anode batteries. An additional reason why only one valve should be used for rectification with this particular arrangement lies in the fact that, if both valves were rectifying, the unidirectional pulses of current of audible frequency produced in each of the circuits by the rectification of the interfering oscillations would tend to produce a steady current, since they would be quite out of phase with each other.

As is well known to workers who have had experience of apparatus of this kind, changes in the value of the filament-heating current by altering what is virtually the resistance of a valve affect, to a certain extent, the frequency of the oscillations generated. This trouble can be lessened to a very great extent by taking the heating current for both filaments from the same battery of accumulators. The filaments can be connected in parallel, but there is more to be gained by connecting them in series, as will be apparent from the figure. It will be seen that, although the two grids are at the same potential with respect to earth, their potentials with respect to the heated filaments are quite different; in the case of the valve shown in the lower half of the figure the potential difference is such that it can "oscillate" only, while the other valve can both oscillate and rectify.

In conclusion, it should be stated that this letter is written with the kind permission of the Director of Artillery, War Office.

P. A. COOPER.

Explosives Branch, Research Dept., Woolwich, April 15, 1922.

A Century of Astronomy.[1]

By Prof. A. S. Eddington, F.R.S.

THE celebration of a centenary is an occasion for retrospect over the past and for hopeful outlook towards the future. We have here representatives of many different sides of astronomy who view it from many different aspects, and I should not be surprised if there are wide differences of opinion as to which are the outstanding landmarks in these hundred years. Like selecting the hundred best books, the selection of, let us say, the six great landmarks of astronomical progress in the century is a pastime which need not be taken too seriously. I shall venture to try my hand at a selection:—

(1) 1839. The first determinations of stellar parallax of 61 Cygni and α Centauri, giving for the first time a definite idea of the scale of the stellar universe.

(2) 1846. The discovery of Neptune. An event perhaps more highly celebrated outside astronomical circles than among professional astronomers, but producing an incalculable moral effect.

(3) 1864–68. The early spectroscopic discoveries of Huggins and Lockyer, and the rise of spectroscopic astronomy.

(4) 1882–87. The beginnings of stellar photography, starting with Gill's photograph of the great comet of 1882 and leading to the inception of the astrographic chart in 1887.

(5) 1904. Kapteyn's discovery of the two star-streams, the beginning of the modern era of investigations of the sidereal system.

Coming to events so near to the present that we cannot yet put much trust in our perspective, I would very tentatively include

(6) 1920. The measurement of the angular diameter of Betelgeuse by Michelson's interferometer method. I would not venture to predict how great or how immediate may be the influence of this last on the progress of astronomy; but it seems to me to be worthy of a place in this select list as a triumph of scientific achievement which is second to none. It is one of those signal instances which convince us that the word "impossible" must be banished from the vocabulary.

This is a record of continuous advance—not in great waves followed by periods of exhaustion. A new impetus has always been found before the last one has begun to fail. Even the allied science of physics has not, I think, had such a continuous record. I am told that there was a period shortly before X-rays and electrons came to the fore, when the physicist had given up anticipating any radical advance; he thought that the big discoveries were already garnered; and the feeling, so present with us to-day, that we are on the verge of something greater than our dreams can shape, had not yet disturbed his placid progress.

The centre of most rapid progress has shifted from time to time, and the various branches of astronomy have had their ups and downs. I suppose that in recent years the department of planetary astronomy has been in the depression of a wave. At least it seems to be so in comparison with the more sensational progress in our knowledge of the sun and stars. Whether we regard the physical observation of the surfaces of the planets or the study of their motions, the openings for advance seem to be few and difficult. But the depression has by no means reached stagnation. We have the remarkable advance in planetary photography, exhibited at several recent meetings of the Society; the discovery of new satellites, including Jupiter's two pairs of twins, and the specially significant phenomenon of the retrograde motion of the outermost satellites of Jupiter and Saturn; the determination of the rotation period of Uranus by Slipher; and the Trojan group of minor planets, the principal merit of which is that they have beneficently prevented the once great science of dynamical astronomy from growing altogether rusty. Renewed interest is added to the exact and regular observation of the positions of planets by Einstein's explanation of the anomalous motion of Mercury; the same observations reveal interesting irregularities in the longitudes of the planets which perhaps reflect inequalities in the rotation of the earth as standard time-keeper. These observations, which else might have seemed to be mere survivals of traditional routine, are seen to be full of importance for the future; and for the same reason we welcome the revival of observations of occultations of stars by planets. On the theoretical side, we have Taylor's important investigation of tidal friction in the Irish Sea, which, true to its name, is responsible for a considerable proportion of the friction and dissipation of energy on this planet; and Jeans's researches have given us new ideas of the origin of the planets which attend the sun, and of the singular (perhaps even unique) character of this system. Many other researches in this field could be mentioned. If the department of planetary astronomy is now the Cinderella of our science, she yet has dreams that her Prince is waiting for her.

It is startling to-day to read a passage from Huxley's "Essays" which runs:—"Until human life is longer and the duties of the present press less heavily, I do not think wise men will occupy themselves with Jovian or Martian natural history." Martian—and I almost fear to mention it—lunar natural history are no doubt thorny subjects, but notwithstanding Huxley's censure, probably the most sceptical among us would admit that the observation of seasonal changes of what is presumably some kind of vegetation on Mars is a recognised astronomical pursuit.

In reviewing the general advance of astronomy during the century, we cannot but be struck by what I may call its *centrifugal* tendency—the tendency to leave the little system ruled by the sun and penetrate deeper and ever deeper into the vast world outside. In the older books, the author leads us deliberately through the planets one by one, and it is with difficulty that the account of the stellar universe can be spun out to any respectable length. Before the first meeting of this Society in 1820 an introductory address was circulated, which contains the paragraph:

Beyond the limits of our own system, all at present

[1] From the presidential address delivered before the Royal Astronomical Society on May 30.

is obscurity. Some vast and general views on the construction of the heavens, and the laws which may regulate the formation and motions of sidereal systems, have, it is true, been struck out; but, like the theories of the earth which have so long occupied the speculations of geologists, they remain to be supported or confuted by the slow accumulation of a mass of facts; and it is here, as in the science just alluded to, that the advantages of associated labour will appear more eminently conspicuous.

While much obscurity still remains, this vast territory has been definitely annexed and occupied. From the planetary system we have passed to the stellar system; and I am not sure if even the study of that great aggregation of stars which we used to think was the whole universe is not becoming a little old-fashioned, and the really up-to-date young astronomer would refuse to bother about anything nearer than a globular cluster. At least it is one of the most startling features of recent research that so much exact knowledge has been obtained of the conditions of stars in globular clusters, not one of which is nearer than 10,000 light-years—knowledge which in many respects far surpasses in precision that which it has been possible to obtain for the much nearer denizens of our own star-cloud.

It may be of interest to examine how this centrifugal tendency is reflected in our Monthly Notices, and I have prepared a table to show how the subject-matter of the papers has changed. The figures claim no great accuracy, because it is often difficult to classify the papers clearly and uniformly; and, of course, the statistics do not distinguish important papers or long-continued observations from trivial notes and controversies. But on the whole the figures seem to be truly representative.

CLASSIFICATION OF PAPERS IN MONTHLY NOTICES, R.A.S.

	1840. (3 years.)	1860.	1880.	1900.	1919.	1920.
Instrumental . . .	6	4	11	3	6	5
Solar System . . .	39	69	73	56	14	21
Stellar universe. . .	18	13	22	21	49	40
Geodesy, navigation, seismology, etc. . . .	14	3	6	..	5	11
Ancient observations .	2	1	1	..	1	1
Mathematical (not classed above)	..	..	2	..	1	12
(Ditto, omitting ephemerides, tabular observations, etc., and formal reports of phenomena.)						
Solar system . . .	9	38	34	21	11	17
Stellar universe. . .	7	11	16	12	33	32

It appears that the serious change did not begin until after 1900. Although it shows itself quite suddenly in the statistics, it had been steadily prepared for during a long period. It must be remembered that much of the heaviest work on the stars is by its nature excluded from the Monthly Notices, and appears only in the more voluminous publications of observatories. Solar, lunar, and planetary observations are not usually too bulky to include. Much long-continued preparation for proper motions, spectral classification, radial velocities, stellar magnitudes, etc., began to come to fruition between 1900 and 1910. But I think the great impetus to sidereal astronomy came from Kapteyn's discovery, which I have mentioned among the six landmarks of the century. The two star-streams were the first taste of the many amazing results contained in the statistics collected or being collected. They were the first indication to us of something like organisation among the myriads of stars. Paradoxical as it may seem, the duality of the stellar system was the first clear indication to us of its unity. In the earlier years most of the papers classified in the table as referring to the stellar universe dealt with particular objects—variables, rapid binaries, Novae. It was a period of individualism. But from 1900 onwards the great democracy of the stars was brought into prominence, and a great wave of stellar socialism began. Kapteyn is the typical pioneer of a numerous body of investigators who view the heavens in the spirit of Xavier le Maistre in "Voyages autour de ma Chambre":

> The most brilliant stars have never been those which I contemplate with most pleasure; but the tiniest ones, those which, lost in immeasurable distance, appear only as barely perceptible points, have always been my favourite stars.

Yet perhaps in the very latest years there has been a reaction towards individualism. The statistical mill is no longer working overtime. The queer stars, such as Cepheids, runaway dwarfs, special binaries, are beginning to contribute more largely to the general perfection of the whole scheme. Strange objects which persist in showing a type of spectrum entirely out of keeping with their luminosity, may ultimately teach us more than a host which radiate according to rule.

It is noticeable that in the early years the disproportionate excess of papers on the solar system compared with the outside regions of the universe was not so marked as it afterwards became. This is no accident. The founders of the Royal Astronomical Society, while confessing almost complete ignorance of this domain, were resolved that it should be attacked, and had the conviction that patient research would make the advance possible. Indeed, it was just this which was placed among the most prominent reasons for banding together. With regard to eclipses, planets, and comets, it might be possible to struggle along individually; but the problems involving thousands of stars were too vast for one man or for one generation. They saw that the observations were being piled up, but without uniformity and without system. To quote again from their address:—

> One of the first great steps towards an accurate knowledge of the construction of the heavens is an acquaintance with the individual objects which they present: in other words, the formation of a complete catalogue of stars and of other bodies, upon a scale infinitely more vast than has yet been undertaken, and that shall comprehend the most minute objects visible in good astronomical telescopes. To form such a catalogue, however, is an undertaking of such overwhelming labour as to defy the utmost exertions of individual industry. It is a task which, to be accomplished, *must* be divided among members; but so divided as to preserve a perfect unity of design. . . . The intended foundation of an Observatory at the southern extremity of Africa, under the auspices of the Admiralty, may serve to show the general sense entertained of the importance of this subject, and the necessity of giving every possible perfection to our catalogue of the fixed stars. Deeply impressed also with the importance of this task, and fully aware of its difficulty, the Astronomical Society might call upon the observers of Europe and of the world to lend their aid in its prosecution. Should similar

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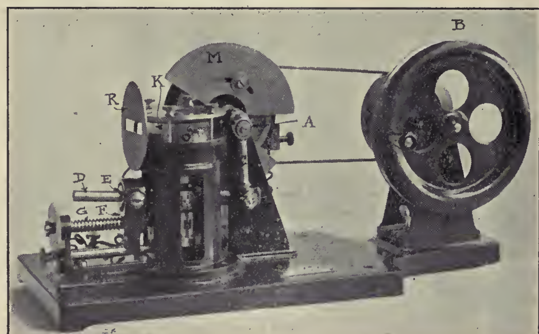

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institutions be formed in other countries, the Astronomical Society (rejecting all views but that of benefiting science) would be ready and desirous to divide at once the labour and the glory of this Herculean attempt, and to act in concert together in such manner as should be judged most conducive to the end in view.

It is largely the Herculean nature of the task before us which has led to astronomy being to-day (whether for good or ill) the most highly organised of the sciences.

The accomplishment of these objects has not been rapid. A passage in the First Annual Report of the Council mentions as one of the greatest desiderata a means of determining the apparent magnitudes of the stars, and ascertaining "a correct scale whereby astronomers may be enabled to express themselves in one common language on this subject." The lapse of a century has not quite sufficed for the completion of this uniform scale; but the main difficulties have been surmounted, and the time is very near now when all astronomers will be able to express themselves in a common language in regard to stellar magnitudes, both visual and photographic.

The foundation of our Society on January 12, 1820, caused a ripple in the aether which has spread out ever since in widening circles. To-day that ripple embraces about 5000 of the fixed stars. The remaining thousand million or so are still outside. Though a good many of the best-known stars must by this time have received the tidings, 90 per cent. of the naked-eye stars are still in ignorance. We should like to think that the stars of the morning sing together with joy on this our Centenary; but the cold truth must be faced that not 1 in 100,000 can yet have heard of our birth. But we shall look out on the heavens again to-night with renewed enthusiasm and joy; and if from the majority of the stars we can expect no more than an unrecognising stare, there are half-a-dozen old favourites which—we may fairly be persuaded—will give us an answering twinkle.

X-Ray Studies on the Crystal Structure of Iron and Steel.

At the annual meeting of the Iron and Steel Institute last year, Dr. Westgren presented a paper on some X-ray crystallographic investigations on iron and steel. At that time the photograms on which his conclusions regarding the crystal structure of the steel components were based were not very clear, and were not published. Moreover, owing to spontaneous crystal growth at high temperatures, the photogram of gamma iron at 1000° C. did not show any continuous lines, but only a few spots. Since then, Dr. Westgren has continued his investigations and improved the experimental arrangements, and in a paper published with Mr. Phragmen at the corresponding meeting of the Institute on May 5 last, he showed photograms of very great interest and significance.

The X-rays were produced in a tube of the Seigbahn type. Difficulties had previously been experienced in obtaining vacuum-tight bronze tubes which composed the metal body. A more suitable material has been found in Skefko ball-bearing steel, which is remarkably free from slag inclusions and heterogeneities. The anti-cathode was cut off perpendicularly to its axis, and in order to get the characteristic X-rays of iron, which are very convenient for these investigations, an iron plate was soldered on to it. Round the radiating surface five windows were made. The tube therefore gave five beams, and exposures could be made in five cameras simultaneously. The tube was evacuated by the combination of a mercury vapour jet pump and a mercury diffusion pump of the Volmer type. Special arrangements were made for maintaining the vacuum of the desired quality. The tube was usually charged with 45,000-50,000 volts and run with 10-12 milliamperes.

In investigating the crystal structure of pure iron at different temperatures, a wire (0·3 millimetre diameter) of vacuum-melted electrolytic iron containing 99·98 per cent. of the metal was investigated. Arrangements were made for rotating this three or four times per minute during exposures. Photograms were taken at the ordinary temperatures, and at about 800°, 1100° and 1425° C., which gave information of the structures of the iron in the alpha, beta, gamma and delta ranges (Fig. 1). The time of exposure was 2½ hours. The lines in the photograms obtained at the ordinary temperatures are clear and sharp, but in the higher ranges of temperature investigated they appear broad and not very distinct. The author explains this as due to the fact that the iron wire at temperatures of about 1400° C. is extremely pliable. Its position, therefore, changed somewhat during the exposure. Moreover, he found it very difficult to keep the temperature of the wire steady in the delta iron range. If the temperature was maintained at 1450° C., *i.e.* within about 70° of the melting point, the wire became so soft that it could not stand the torsion. The temperature, there-

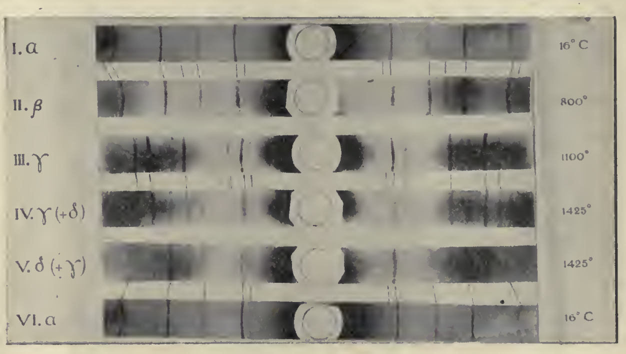

FIG. 1.

fore, had to be kept not above 1425° C., which is near the delta-gamma transformation point. Moreover, it was found necessary to counteract the influence of grain growth at these very high temperatures. For this purpose the temperature was varied every 5 or 10 minutes so as to bring the iron into the range of another modification, *e.g.* in taking the beta iron photogram the temperature was raised from time to time to about 1000° C., and when the gamma and delta irons were investigated the heating current was broken off now and then, so as to let the wire cool down into the alpha range. Photograms of delta iron, which always contained some gamma iron, show, accordingly, lines characteristic both of the delta and gamma varieties.

Experiments carried out on the above lines show that alpha, beta, and delta irons have a body-centred cubic lattice, whereas gamma iron has a face-centred cubic lattice. The former lattice contains an atom at each corner of the cube and one in the centre, the latter has an atom at each corner and also in the centre of each face. It follows, therefore, that although there are generally considered to be four modifications of iron, three of them possess one and the same crystal form. For alpha iron at the ordinary temperature a has been found to be 2·87 Å.U.; at 800° C. it has increased to 2·90 Å.U., and at 1425° C. to 2·93 Å.U. This agrees very well with the known dilatation coefficient of alpha iron. The heat expansion of gamma iron also manifests itself in the increase of alpha-gamma from 3·63 Å.U. at 1100° C. to 3·68 Å.U. at 1425° C., which agrees well with the fact that the coefficient of gamma iron is greater than that of alpha iron.

At first sight it appears rather startling that the transformation which takes place at A_3 (beta to gamma) is reversed at the higher temperature A_4 (gamma to delta). However, the diagrams of Weiss and Foëx which the author reproduces, showing the change of magnetic susceptibilities of iron, indicate that alpha, beta and delta iron probably possess one and the same structure. Evidence as to the existence of delta iron has gradually been accumulating during recent years, and this modification can now be regarded as being well established. Henceforth, it must take its place in the iron-carbon equilibrium diagram.

Great interest attaches to the authors' experiments on the influence of carbon on the space-lattice of iron in hardened steels (Fig. 2). These show that the gamma-iron lattice of austenitic steels is enlarged by dissolved carbon. A steel with 1·98 per cent. carbon has been found to have a somewhat larger lattice when quenched from 1100° C. than from 1000° C. The investigations thus show that carbon has a distorting influence on the lattice, and a further interesting point concerning this effect may be noted. The carbon atoms may be situated in the cavities of the iron lattice, but the author concludes that they are distributed quite irregularly in the austenite crystals. If their deforming influence were of a local nature, the interference radiation would be diffuse. The lines of the photograms of the austenite containing high carbon are, however, very distinct and clear, thus proving that the iron lattice is uniformly deformed.

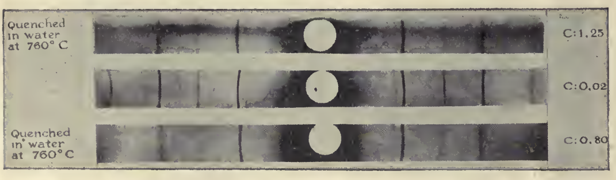

FIG. 2.

Photograms of martensite, the characteristic constituent of hardened steel, show three very faint and diffuse lines, but their cloudiness makes it difficult exactly to determine the position of their intensity maxima. The a-values of the alpha iron in martensite are not, therefore, so trustworthy as those of gamma iron in austenite, but the various modifications of iron in all the four photograms published have given the same value, namely, 2·90 Å.U., which indicates that the alpha iron lattice of martensite is likewise enlarged by the carbon atoms present. On the basis of these results, the authors discuss the deeply interesting question, whether martensite is a two-phase system or a homogeneous solid atom disperse solution. If the iron lattice is uniformly deformed, it seems probable that martensite, like austenite, is a true solid solution of carbon of iron. If, however, the photogram of martensite is identical with that of pure alpha iron, it would indicate that the hardened steel contains a mass of alpha iron particles, free from carbon. The photograms thus far obtained point in the direction of the first of these possibilities, and it seems probable that martensite is a real atom disperse solution. The diffuseness of the line in the photograms gives very important information as to the structure of this constituent. As Scherrer shows, the lines of a Debye-Scherrer photogram get broader and more diffuse in proportion as the crystal powder is more finely divided. No quantitative comparisons have yet been made for martensite, but from a qualitative comparison, of a film of steel (0·80 per cent of carbon), with the photogram of an extremely fine-grained gold colloid, the authors conclude that the steel is as highly disperse as the colloid. The lines of the martensite seem to be about as broad as those in the gold photogram. The ranges of homogeneous lattice in the steel have accordingly, on an average, an extension of about 20 Å.U., and each of them contains only a few hundred atoms.

In the concluding section of their paper the authors publish photograms of the iron carbide, cementite, Fe_3C. This they have found to be identical with the well-known crystal plates of speigel iron. By means of a Laue photogram and investigations of an orientated rotating crystal of speigel, it has been possible to deduce the crystal data of cementite. The authors conclude that it belongs to the orthorhombic system. Its ratio of axes is 0·670 : 0·755 : 1. The dimensions of its elementary parallelopiped are 4·53, 5·11, and 6·77 Å.U. The base group consists of four molecules, Fe_3C, which corresponds to a specific weight of 7·62 for cementite.

H. C. H. C.

Wireless Telephone Receiving Sets.

A NUMBER of patterns of complete wireless telephone receiving sets are being introduced to meet the requirements of the popular broadcasting services which will shortly be put in operation. It is regrettable that there has been a tendency, in striving after simplicity and cheapness, to cut the apparatus down to rather fine limits, resulting in the elimination of adjustments and features which are most desirable for really satisfactory working. Indeed many of the sets being advertised are little better than toys. It is true that reception of a sort is quite possible with elementary crystal sets, but the unskilled user will undoubtedly be better served by the slightly more expensive valve apparatus which is now being made in simple and convenient forms.

We have had the opportunity of inspecting an equipment supplied by the firm of Radio Supplies (236 High Holborn, W.C.1) which is typical of a good class of apparatus of this sort. This firm's M type set, which is sufficient for all ordinary reception, is of the two-valve pattern, one valve acting as detector and the other as amplifier, the latter being in the low-frequency circuit, forming what is termed a note-amplifier. The valves with their filament rheostats, switches, terminals, etc., are mounted on a compact case, but the aerial inductance is carried on a separate stand. In this the convenient arrangement is adapted of obtaining a variable coupling by turning a simple milled head, which alters the relative angular position of the coils in question. Alternative coils, which can easily be plugged into place on the swinging arm, are used for different "bands" of wave-lengths. The fine tuning adjustment is obtained by a very compactly arranged variable condenser, and by this means the apparatus can be tuned to any wave-length from 180 to 30,000 metres.

With the pattern of valve employed a six-volt accumulator is generally used for the filament circuits, and it is recommended that this be of the 60 ampere-hour size, if the apparatus is in daily use for long periods, as then it will not have to be charged more than about once a week. It is, of course, possible in places where there are absolutely no facilities for recharging accumulator cells, to use large dry cells for the filaments. The high-voltage or anode circuits of the valves are supplied by compact multicell dry batteries at voltages from 30 to 70 volts according to circumstances. These are made up in blocks about 8 inches long of 30 cells each, and in view of the very small current taken from them, should last nine months without renewal.

A set of this kind, which complete with a small aerial and every accessory would cost from 25*l.* to 30*l.*, will pick up in addition to telephony, spark, tonic train, or continuous wave signals. Even with an indoor "aerial," the concerts from the Hague are audible all over the room, with an ordinary telephone receiver. The firm also supply larger sets with further degrees of amplification, but for all ordinary work two valves are quite sufficient.

Obituary.

PROF. A. LAVERAN, FOR. MEM., R.S.

FRANCE lost one of her great men of science when Charles Louis Alfonse Laveran died on May 18 at the ripe age of seventy-six. His death, following so closely on that of Sir Patrick Manson, may be said to close one chapter in the history of malaria, the important preliminary chapter which paved the way for the brilliant and far-reaching researches of Ross and the Italian observers.

Laveran was born at Paris on June 18, 1845, his father, a military surgeon, being a professor at the school of Val-de-Grâce. The son followed in his father's footsteps, for, after completing his studies in Paris, he decided to become an army doctor, and matriculated as a medical student at Strasbourg. He graduated in 1867, submitting a thesis on the regeneration of nerves. In 1874 he joined the staff of the Val-de-Grâce School of Military Medicine, and in 1878 was sent to Algeria, where he remained till 1883. It was in this country, at Bône and at Constantine, that he turned his attention to malaria, and carried out the memorable work with which his name will for ever be associated.

As a result of his labours Laveran was appointed, in 1884, professor of military hygiene and clinical medicine at Val-de-Grâce, posts which he held for ten years. Thereafter, for a short space, he was concerned with administrative medical and sanitary work at Lille and at Nantes, but his heart was given to scientific pursuits, and, desirous of continuing his researches, more especially in protozoology, he relinquished his appointments in 1897, and retired with the rank of *médecin principal* of the first class.

Laveran then entered the Pasteur Institute where he soon became a professor. There he remained for the rest of his life, always busy, a tireless investigator who never flagged until age and infirmities conquered even his indomitable spirit, and he was no longer able to use his beloved microscope and pursue those studies to which he had devoted his life to such good purpose. As Prof. Brumpt pointed out in his address to the Academy of Medicine, a failure in Laveran's powers was noticeable after the fêtes in connection with the centenary of that Institution in which he took an active part. The effort exhausted him, and he no longer attended the meetings of scientific societies with his wonted regularity, a sure sign in his case of the approaching end.

Laveran's greatest work, and that which entitles him to a place in the medical Valhalla, was his discovery of the parasite of malaria. In Algiers he commenced his studies on the pathology of that disease, and his attention was specially directed to the characteristic pigmentation of the liver and brain in fatal cases. This had already been recognised, but it was

Laveran who demonstrated pigment granules in certain bodies exhibiting amœboid movements in the blood. These bodies were crescentic or spherical in shape, and he looked upon them as of a parasitic nature, though it was not until 1880, when at Constantine, that all doubts were swept from his mind by his discovery of the phenomenon known as "flagellation of the male crescent." So remarkable were the appearances presented that he no longer hesitated to declare his belief.

As is always the way in this conservative world when something new and strange is revealed, there was much scepticism as to the validity of his findings, but Laveran, who possessed most of the qualities of the successful investigator, was not to be daunted. By a series of careful observations, pathological, clinical, geographical, and therapeutic, he routed his opponents and eventually satisfied the scientific world that his conclusions were well founded.

Laveran shared the view which King advanced in 1883 that human malaria was a mosquito-borne disease, but he had no opportunity of testing the theory, which was finally established as a fact by Grassi, Bignami, and Bastianelli in Italy in 1897 after Ross had, in India, completed his epoch-making work on the transmission of bird malaria by culicines, and had seen the early stages of the development of the human malaria parasite in anophelines.

The Academy of Science set its seal on Laveran's discovery in 1889 and elected him a member in 1895. In 1893 he became a member of the Academy of Medicine, and he also joined the Society of Biology. It was not, however, until the true significance of his researches had been rendered apparent by the work which resulted from them that Laveran's claims to be in the first rank of living men of science were fully recognised. Then, indeed, he was paid the honour which was his due, and among many other distinctions was given the Nobel prize for medicine in 1907.

Together with some of his colleagues Laveran founded the Société de Pathologie Exotique, of which he was the first president, and during the dozen years of his chairmanship the society prospered greatly. In the *Bulletin* of the society many of Laveran's papers were published, and he did much to forward the cause of tropical medicine and hygiene throughout the French colonial possessions.

Laveran, like Manson, inspired others with his enthusiasm, and was an acknowledged leader in his own subjects. He wrote much on malaria, and collected his contributions in the well-known "Traitè de Paludisme" in 1898, of which a second edition appeared in 1907.

His work at the Pasteur Institute was most prolific, and much of it was carried out in collaboration with Prof. Mesnil. Together they produced an important work on trypanosomes and trypanosomiasis, which reached a second edition, and was a mine of well-arranged information. Laveran was well qualified to write on the subject from the laboratory standpoint, for he conducted a great deal of experimental work on trypanosome infection, and tested many remedies with the view of finding a cure for sleeping sickness. Turning his attention to leishmaniasis, he published the first treatise on this subject, the study of which led him to investigate many of the flagellate parasites of man and animals. The sporozoa of animals had earlier attracted his attention, and he investigated the properties of sarcocystine, the first toxin extracted from a sporozoon, and the pathogenicity of which was determined by Pfeiffer.

Considerations of space prevent any full account of Laveran's manifold activities. He was never idle, and no sooner was one piece of work completed than he was busy at another. His conclusions have not always been generally accepted, but he had ever the courage of his convictions, and adhered to his well-considered views with that tenacity which was so strong a feature of his character. In reality a kindly man, he was apt to be considered a trifle brusque by those who did not know him, especially if they trespassed overmuch on his working hours, but he was ever ready to aid the genuine inquirer and also to give credit where credit was due. He was precise and accurate in his work, careful in his writings, and possessed in a very high degree the scientific habit of mind, qualities which enabled him to stamp his personality on whatever he undertook, and will entitle him, for all time, to a foremost place in the ranks of those who have advanced the causes of parasitology and medicine in the tropics. A. B.

DR. J. RENÉ BENOÎT.

THE world of science has suffered a severe loss by the death at Dijon, on May 4, of Dr. J. René Benoît, honorary director of the Bureau International des Poids et Mesures, Sèvres. Dr. Benoît, who was born in 1844, commenced his scientific career in the study of medicine, but, having attained his doctorate, transferred his attention to pure physics, working first in Jamin's laboratory, where he prepared a thesis on the electrical conductivity of metals. After some years in industrial life he joined the Bureau International in 1878 as assistant director to Dr. O. J. Broch, whom he succeeded as director in 1889. It was at the Bureau International that his great work was achieved. His first investigations were related to the improvement of thermometric and barometric measurements, and were followed by very careful experiments directed to the measurement of thermal expansions, particularly with the Fizeau apparatus, which he greatly perfected, and which continued to hold his interest to the end of his career. Dr. Benoît took a large personal share in the work of verifying the principal series of prototype metres, and executed a number of very accurate comparisons of the International Metre with other current standards of length, including the British Imperial Yard and the ancient Toise du Pérou and Toise de Bessel, on which the original French metre and the geodesic measurements of central and western Europe had formerly been based.

In 1891 Prof. A. A. Michelson was invited by the Comité International to carry out at the Bureau his contemplated researches into the relation between the metre and the wave-length of light. Dr. Benoît threw himself enthusiastically into this work, and was closely associated with it throughout. Again in

1906, when MM. Fabry and Perot took up the same investigations by the new method of superposed fringes, he gave them the full benefit of his earlier experience and every assistance in his power. The remarkable concordance (the difference was not much in excess of one part in ten million) between the results of the two investigations is sufficient testimony to the accuracy of the earlier work, and although possibly it must be admitted that fortune played its part, and that the absolute accuracy was not quite so high as the agreement between the two results appeared to indicate, an accuracy not inferior to one part in a million may, in any case, safely be considered to have been attained.

Dr. Benoît was associated also with the researches of Dr. Ch. Ed. Guillaume, the present director of the Bureau, into the properties of invar, and was closely concerned with the early standardisation of the 24-metre Jäderin surveying wires, which are now almost universally employed in the measurement of geodesic base-lines. He was further interested, from his earliest days, in questions of electrical standardisation, and spent much time in determining the value of the standard ohm. This work, however, was not part of the regular programme of the Bureau, and the pressure of his other duties prevented him from devoting so much attention to it as he would have liked; but for a period the standard ohm produced by Benoit was the accepted type for precision measurements, and the value he obtained was very close to that accepted at the present time. He was still at work on this subject when failing health and eyesight caused him, in 1914, to tender to the Comité International his resignation of the directorship which he had held with so much distinction.

To appreciate the value of Benoît's work and his unsparing labour and painstaking attention to every detail making for precision of results, it is necessary to read the "Travaux et Mémoires" of the Bureau during the period of his direction. In appreciation of his services the Comité International, on his retirement, appointed him honorary director, and he was present in the autumn of 1921 at the sixth Conférence Générale des Poids et Mesures, showing all his old enthusiasm for the work which had filled his life. He had a most unassuming and charming personality, and those who had the privilege of knowing and collaborating with him will feel a very real and personal loss in his death. He was past president of the Société Française de Physique and correspondant of the Institut de France, of the Bureau de Longitudes, and of the Académie des Sciences, honorary fellow of the Physical Society of London and of the Société Française des Électriciens, and officer of the Legion of Honour.

J. E. S.

JOHN WANKLYN MCCONNEL.

A COMBINATION of business ability and legal training with real experience of agriculture as well as of textile engineering, directed by a passion for constructive organisation, brought the late Mr. J. W. McConnel to occupy an exceptional position as an exponent of industry in relation to science, and his death on May 25 at the age of sixty-seven is more than premature. His grandfather founded the firm of McConnel & Co., fine cotton spinners, whose mills are now the second largest in the world, in 1797, and Mr. McConnel was thus one of the aristocrats of the industry. The purchase by McConnels of the English patent rights of the Heilman Comber gave him, as a young man, an exceptional experience with the one new machine which the industry has evolved during the century; this experience influenced his outlook in later years, and seemed to render him much less convinced of finality than most cotton spinners, and hence more eager for the application of scientific methods. Incidentally, it may be mentioned that he was one of the first two students in the then new school of engineering at Cambridge. Thus he was led to advance a scheme for the formation of a special department in Manchester University at the British Association meeting of 1915; but, failing to secure a permanent endowment, he obtained the co-operation of the Fine Cotton Spinners' and Doublers' Association to undertake the proposed scientific work, which has since steadily developed into an experimental department of the combine with workshops and spinning mill as well as laboratories.

The original intention was merely in advance of public opinion, for only two years later Mr. McConnel became chairman of a provisional committee of the Department of Scientific and Industrial Research. He resigned the chairmanship, after two years' work, before the British Cotton Research Association was actually constituted, but not before he had laid the foundations of an immense organisation which embraces the whole industry, and aims at breaking down the watertight compartments into which a highly efficient but conservative industry had segregated itself. It is pleasant to recall the graceful acknowledgment of this "spade work" recently made by Mr. Kenneth Lee at a luncheon when H.R.H. the Duke of York formally opened the Shirley Institute, Mr. McConnel being present as a guest.

The thesis of essential community of interest between grower and spinner had found a strong supporter in Mr. McConnel. Travels to the West Indies, Egypt and the Sudan, supplemented by an active personal supervision of a very large cotton-growing plantation in Mississippi, and of his own estate in Ayrshire, placed him in an exceptional position as an authority on spinning who also knew a great deal at first hand about cotton-growing. Having first applied this experience in laying the broad foundations of the British Cotton Industry Research Association, he developed it further on the committees set up by the Board of Trade, his appendix to the Textile Committee's report leading to the formation of the Empire Cotton Growing Committee, and when the committee was transmuted into the Empire Cotton Growing Corporation under royal charter, Mr. McConnel became chairman of its council.

Mr. McConnel was most remarkable in an ability for learning new methods, subjects, and viewpoints which would have been unusual even in a much younger man. The work he initiated for the cotton industry was neither superficial nor conspicuous, but its effects will endure, and he will be remembered as one of those who thought for to-morrow as well as for to-day.

F. W. SANDERSON.

MR. FREDERICK WILLIAM SANDERSON, headmaster of Oundle School, whose tragic death occurred on Thursday, June 15, at the close of an address to the National Union of Scientific Workers on "The Duty and Service of Science in the New Era," made a deep and lasting impression upon scientific education in this country. He had just concluded his address, and Mr. H. G. Wells, who presided, had described him as the greatest headmaster that ever lived, when he slid from the chair in which he was sitting, and a few minutes later died from heart failure. Mr. Sanderson, who was born on May 13, 1857, was 11th wrangler at Cambridge in 1882, and assistant master at Dulwich College from 1885 to 1892, when he was appointed headmaster of Oundle School, Northants, which he transformed from a small and relatively unknown institution to a great and leading educational power. No Public School in the kingdom possesses such laboratories and workshops, and in none is it possible for a boy to be better prepared for worthy citizenship in a modern community. In all subjects Mr. Sanderson introduced methods of instruction which are both effective and stimulating. The practical method of teaching science is combined with lessons on the romance of the subject and points of contact with the action of Nature and the work of man in everyday life: library research is encouraged in connection with history and literature: English by reciting and acting an adapted play of Shakespeare's every term: languages by direct methods, and so on throughout the curriculum. Mr. Sanderson was not only an original thinker but also a tireless experimenter in educational methods, and his breadth of interest was so great that the classical and literary work at Oundle is as distinctive as that in science. The spirit of it all is that of education for service—creativeness rather than personal possession—and Mr. Sanderson's last words were a plea for this uplifting principle in every school. Oundle remains a noble monument to his high ideals and their successful achievement.

WE much regret to see the announcement of the death, on June 18, of Prof. J. C. Kapteyn, foreign member of the Royal Society and professor of astronomy and mechanics in the University of Groningen, Holland.

Current Topics and Events.

DIRE experience, in the form of aerial disasters, is emphasising the fact that the new form of locomotion possesses points of difficulty, and that the complexity of the problems presented is unparalleled in any of the older branches of transport. In delivering the annual lecture in memory of Wilbur Wright before the Royal Astronomical Society on June 15, Mr. Alec Ogilvie dealt with some aspects of the problem, and his address contains the following striking paragraph: "It is not my wish to exaggerate the importance to the world's knowledge of aeronautical research of the Wright brothers, but it is my desire to lay the strongest emphasis on the lesson to be learnt therefrom—namely, that the whole basis of aeronautical progress rests on genuine research in the laboratory, on the development of mathematical lines of attack, and on full scale research work in the field, and cannot possibly rest only or even mainly upon technical development." The lecturer said that the national effort put into aerial research was now far below the pre-war standard, and that the importance of fundamental research is not grasped by those in authority in this country. It may be recalled that the Royal Aeronautical Society, to which Mr. Ogilvie was speaking, has taken an active part in bringing the views of scientific aviation to the notice of the Air Ministry, and is the accepted representative body for that purpose. Moreover, during the later stages of the war, when aviation was taking a leading part in fighting operations, Mr. Ogilvie was responsible to the Air Board for its new designs of aeroplane, and this lends additional interest to his statement that "our rapid technical development during the war period, in which we as a nation overtook both friends and enemies after starting a long way behind, was mainly due to the solid research work which was done in the laboratories of this country between 1909 and 1914. It appears to me, however, that there is some danger that the real lessons of the past have not been understood and taken to heart." Mr. Ogilvie claimed for the Wright brothers a greater measure of praise for their demonstration of the firm structure of knowledge than for their superior skill and technique. The latter has hitherto been appreciated and the former neglected, but indications, still only straws, seem to point to a more even balance between research and technique in the immediate future of aviation.

THE Mount Everest expedition has made another new record in altitude. The *Times* announces that Messrs. Finch and Bruce with one Gurkha camped at 25,000 ft. for two nights and, employing oxygen, finally attained an altitude of 27,200 ft. This is 400 ft. above the record reached by Messrs. Mallory, Somervell, and Norton on May 21, and only 1800 ft. below the summit of Mount Everest. The *Times* also publishes a long despatch from General Bruce, giving details of the organisation of camps and transport on the Rongbuk glacier and Chang La (North Col). The route to the highest camp, at Chang La, was very trying, and unsettled weather added to the difficulties, but each camp was made self-complete with stores and equipment, the Chang La camp having food for ten British and a large number of porters, besides a full Alpine kit and the oxygen apparatus. It has been proved that up to 25,000 ft. a camp can be established without employing oxygen, and this gives considerable hope for the final assault on the summit. In the same despatch Mr. Mallory gives an account of the climb from Chang La camp to 26,000 ft. This altitude was reached without much more physical discomfort than

was experienced some 7000 ft. below, but one of the party, Maj. Morshead, was overcome and had to fall out. In such a case long rest at a lower altitude seems to be essential. The pace was very slow, but a greater height could possibly have been reached if the necessity for returning to the camp had not led Mr. Mallory to believe it wise to turn before the north-east shoulder was reached.

THE long drought of 1921 has been followed by excessive flowering of many kinds of trees and shrubs during the present spring, but in no instance has this been more noticeable than in the hawthorn, for both as a cultivated plant and as a wilding it has rarely been known to flower so freely. Dr. C. J. Bond, of Leicester, directs attention to this subject in a letter just received. In addition to its blossoming more freely than usual, hawthorn has been remarkable from the fact that a considerable number of plants have borne pink or pink-tinged flowers. This has given rise to speculation as to the reason for the sudden appearance of so many pink-flowered plants, and suggestions have been made that it may be due to the abnormal conditions of sunshine and drought obtaining last year and during the present flowering time, or to a process of evolution that is gradually taking place in the species. But pink-flowered hawthorns have not been uncommon in a wild state in the past, and it is doubtful whether the actual percentage of pink-flowered plants is any higher this year than in any previous year, but so many more plants than usual are flowering that they attract more attention. Pink and red flowered hawthorns have been grown in gardens for a very long period, and not infrequently they have been planted in parks, hedgerows, and on the outskirts of woods. Seed collectors in autumn are unlikely to distinguish between these and white-flowered trees, while birds are even less likely to discriminate. From such seeds, plants bearing white, pink, or pink-tinged flowers may be expected. These plants, used for field hedges, may 30 or 40 years later run wild and appear as trees, or seeds carried by birds and dropped in uncultivated ground may produce pink-flowered trees. While interesting, the appearance of pink-flowered hawthorns under wild or semi-wild conditions cannot be regarded as a new phenomenon or of great botanical importance, and it is unlikely that any marked natural change in the colour of the flowers throughout the species is in progress.

AN interesting discovery of a prehistoric village site is reported from Sidmouth. During the last year, workmen who have been employed in laying out the grounds of the residence of Mr. D. Chambers in Sidroad, have brought to light a number of objects, more than three hundred in all, and ranging in date from neolithic times to the eighteenth century. The finds include stone axes, arrow-heads, scrapers, flint knives and cores, a quantity of pottery, objects probably of Saxon and Norman date, and modern glass, of which one fragment is dated 1717. One object of flint, about one inch in diameter, is claimed to be a representation of the human face. Many of these objects were found in the course of removing old earthen banks, some of which may possibly have formed part of the original protective works of the site. The river and an adjacent brook provided an ample water-supply, while the site, which is well above the level of the river meadows, is situated within a quarter of a mile from the old Roman road from Exeter to Lyme Regis. The discovery is of particular interest in view of the evidence it affords of continuous occupation over such a considerable period of time. The objects discovered are now on exhibition in the house of the owners of the site and are available for the inspection of visitors, but ultimately a selection from them will be presented to the town.

THE Albert Medal of the Royal Society of Arts for 1922 has been awarded by the Council, with the approval of the president, H.R.H. The Duke of Connaught and Strathearn, to Sir Dugald Clerk, in recognition of his important contributions, both theoretical and practical, to the development of the internal combustion engine, which in its later forms has rendered aerial navigation possible, and is also so extensively employed in the motor car, in the submarine, and for many other purposes. The Albert medal was founded in 1863 as a memorial of the Prince Consort, who was president of the Society from 1843 to 1861, and is awarded annually "for distinguished merit in promoting Arts, Manufactures, and Commerce."

THE annual conversazione of the Institution of Civil Engineers will be held on Tuesday, June 27, at the Institution, at 8.30 P.M.

THE Jenner Medal of the Royal Society of Medicine has been awarded to Dr. J. C. McVail, and will be presented at the annual dinner of the Society on Thursday, July 6.

MR. J. H. NICHOLSON, assistant lecturer in education in the University of Bristol, has been elected to an Albert Kahn Travelling Fellowship. The value of the fellowship is 1000*l*.

BY invitation of the director of the Royal Horticultural Society's Gardens, Wisley, Ripley, Surrey, the annual field meeting of the Association of Economic Biologists will be held in the Gardens on Friday next, June 30.

THE annual general meeting of the Research Defence Society will be held at the house of the Medical Society of London, 11 Chandos Street, Cavendish Square, W.1, on Tuesday, June 27, at 3.30. The chair will be taken by the Rt. Hon. Viscount Knutsford, and a short address will be given by Sir Walter Fletcher on medical research and national life.

IN connection with the annual general meeting of the Eugenics Education Society a conference on "The Inheritance of Mental Qualities, Good and Bad," will be held at the Royal Society, Burlington House, on Tuesday, July 4, at 5.30. Among the speakers will be Dr. Tredgold, Dr. C. H. Bond, Dr. Bernard Hollander, and Mr. R. A. Fisher.

THE following officers and members of council of the Röntgen Society have been elected for the session 1922–1923: *President*: Sir Humphry Rolleston; *Vice-Presidents*: Sir W. H. Bragg, Sir Ernest Rutherford, and Dr. A. E. Barclay; *Hon. Treasurer*: Mr. Pearce; *Hon. Secretaries*: Dr. E. A. Owen and Mr. R. J. Reynolds; *Hon. Editor*: Dr. G. W. C. Kaye; *Council*: Mr. C. Andrews, Dr. G. B. Batten, Mr. A. E. Dean, Mr. K. Edgcumbe, Mr. N. S. Finzi, Dr. F. L. Hopwood, Dr. F. H. Johnson, Mr. C. E. S. Phillips, Prof. A. W. Porter, Prof. A. O. Rankine, Sir Archibald D. Reid, and Dr. R. W. A. Salmond.

REFERRING to a paragraph in NATURE of June 10, p. 755, Dr. Marie C. Stopes writes:—"May I correct the impression your paragraph creates that the Clinic and the *Birth Control News* are activities of the Malthusian League, as this is not the case? The Society for Constructive Birth Control and Racial Progress, with which the clinic and news are associated, is a distinct society with a different basis. The policy of the Clinic and the *Birth Control News* is that of *constructive* and scientific control, as distinct from what is commonly understood as Malthusianism."

WE have received from Messrs. C. F. Elwell, Ltd. (Craven House, Kingsway) a handsomely produced catalogue relating to apparatus for wireless communication. A readable introduction deals with the immensity of the field of wireless telegraphy and the superiority of the continuous wave over the spark system of transmission. The most interesting portion is that dealing with the Elwell arc equipment on the Poulsen system, such as the company has supplied to several well-known long-distance stations, including Horsea, Eiffel Tower, Lyons, Rome, and the initial station of the Imperial Chain at Leafield. This apparatus is listed up to 700 amp. in the arc. Interesting details are also given of steel and wooden lattice aerial towers, ship receiving sets, and various accessories.

Our Astronomical Column.

THE METEORS OF PONS-WINNECKE'S COMET.—Mr. W. F. Denning writes that he regards it as highly probable there may occur a meteoric shower on about June 28. It will be a return of the display which he witnessed on June 28, 1916. If the meteors of this stream are connected with the comet of Pons-Winnecke, they will have a period approximating six years, and as the particles appear to be distributed abundantly along a lengthy section of the orbit, a repetition of the phenomenon of 1916 may be expected. It is true that the cometary meteors were not seen at many stations last year, although the conditions appeared promising, but in Japan a considerable number seem to have been recorded. In any event it is desirable carefully to watch the heavens, at the end of June, for further evidence of this interesting display. There will be no moonlight, and the radiant point in Quadrans or Draco will be favourably placed in the earlier hours of the night.

THE SEARCH FOR NEW STARS.—The period of the year is now approaching when the Milky Way will be very favourably placed for observation in northern latitudes, especially towards the end of June, and in July. The constellations Cygnus, Aquila, Ophiuchus, and Scorpio have been fruitful in Novæ in past years, and they offer the prospect of further discoveries. When the moon is not bright the sky in the regions indicated should be scanned carefully for new objects. The best time to conduct the work will be near midnight, when the summer twilight will not seriously interfere.

An observer who is not familiar with a large number of the naked-eye stars, should compare the heavens with a star atlas, and this method, often repeated, will soon enable him to dispense with the atlas. Certain new stars are very quick in their rise to brilliancy, and a vast difference in their magnitude often occurs in a few hours, so that it is really essential to repeat the search several times in the course of a night. Wherever the galaxy runs the observer's eyes should diligently pursue the quest, and other quarters of the sky should occasionally receive attention.

Though twelve new stars visible to the naked eye burst into view between 1848 and 1921, not one appears to have been recognised during the previous 158 years; but this was probably due, not so much to the dearth of such objects, as to the want of capable observers.

COLOURS OF BINARY STARS.—The giant and dwarf theory of star-development gave a solution to an astronomical enigma of long standing. This was the frequency with which the fainter component of a binary tends to blue, while the brighter component is red or orange. On the old view this implied that the component was of earlier type than the bright star, and hence had developed more slowly. Some suggested, as a way of escape, that the blue of these stars might possibly not correspond with that associated with spectral type A or B. It was, however, found possible to obtain spectrograms of some of these blue components, which did not indicate that they differed from other blue stars. As soon as the giant and dwarf theory was mooted, it became clear that for giant stars the blue stage was in fact later than the red or yellow one.

Mr. Peter Doig examines the question from this point of view in Mon. Not. R.A.S. of April, and finds that it gives much the same line of demarcation between the giant and dwarf binaries as that given by the absolute magnitudes, based on all available parallaxes, including the spectroscopic ones. He gives 33 pairs in which the stars are giants, and 75 in which both are dwarfs. The former list includes Polaris, Regulus, Antares, β Cygni, ξ Bootis, etc.; the latter includes Castor and α Centauri. Mr. Doig notes that in some cases of great difference of mass the companion might have become a dwarf of a redder type than the primary, while the latter was still a giant. He then ventures to extend the principle to give estimated parallaxes for some systems not on the list. For example, α Librae is given as a dwarf, with parallax $0{\cdot}045''$; the parallax of Praesepe is estimated as $0{\cdot}010''$. The paper makes an appeal for the substitution of other terms for "early" and "late" as applied to spectral types, which are misleading in the case of giants. Prof. Turner suggested the terms "hotter" and "cooler" as preferable.

Research Items.

FRAZER MEMORIAL LECTURES.—Some admirers of Sir James Frazer's work in social anthropology have contributed to a fund for the establishment of an annual lecture at Oxford. The first lecture in the course was recently delivered by Dr. E. Sidney Hartland, who naturally selected as his study a subject which he has made his own, "The Evolution of Kinship," based upon the important monograph by Edwin W. Smith and the late Andrew M. Dale on "The Ila-speaking Peoples of Northern Rhodesia." The Ba-ila, or Ila people, inhabit the very centre of the continent, on the banks of the Kafue, a tributary of the Zambesi, being descendants of more than one stream of Bantu immigrants from the north and north-east, coming probably by different routes and at different times. The social organisation of this primitive and hitherto little-known community has been skilfully investigated by Dr. Hartland. Like all Bantu tribes, their civilisation is based on the matrilinear clan, the family being a newcomer into the social field, which is struggling with the clan for influence. Its development into a patrilinear institution is plausibly accounted for by the rule that on marriage a wife goes to her husband's dwelling and makes her home there: he does not come to that of her kindred. Thus the developmental sequence, as among the Australian tribes, is from mother to father right. If succeeding contributors to this foundation maintain the high level of Dr. Hartland's inaugural lecture, the Frazer Memorial Lecture marks an important extension of the study of social anthropology in this country.

AN INSECT DESTRUCTIVE TO FLAX.— In the Scientific Proceedings of the Royal Dublin Society, vol. xvi., April 1922, Mr. J. G. Rhynehart contributes an interesting and well-illustrated paper on the flax flea-beetle (*Longitarsus parvulus* Payk.). This species is a serious enemy of flax and one responsible for considerable loss to growers of the crop in Ireland. It is commonly found throughout Ulster, and of recent years has become a pest in flax-growing districts in Co. Cork. The adult beetle kills many of the seedlings by devouring the cotyledons and growing-point of the flax, but will also eat clovers, grasses, and wild species of flax. The larvæ bore into and feed on the roots of the flax plants, but do not appear to cause any appreciable hindrance to growth. Preventive measures consist of the production of strong, vigorous-growing brairds by the employment of suitable cultivation, seed, and manure; in the destruction or removal of all material likely to afford means of hibernation for the adult beetle; and in the stimulation of attacked seedlings by the application of a light dressing of nitrate of soda. Preliminary experiments indicate the possibility of the use of Bordeaux mixture as a deterrent.

NEW FOSSIL SEA COW FROM FLORIDA.—The hinder part of the right maxillary of a species of Metaxytherium, from the phosphate beds of Mulberry, Florida, is described and figured by Mr. O. P. Hay under the trivial name of *M. floridanum* (Proc. U.S. Nat. Mus., vol. lxi.). Its exact geological horizon is uncertain: it belonged probably to the Upper Miocene or Lower Pliocene, while European species belong to the Miocene or in part to the Oligocene.

PALÆONTOLOGY OF THE BURMA OILFIELDS.—For some years Mr. E. Vredenburg has been accumulating data regarding the marine fauna of Tertiary age in Burma, and the large quantity of material collected by officers of the Geological Survey of India, as well as by the geologists of the principal oil companies, now permits of a marked advance on the results as they were left by Dr. F. Noetling in 1897. A general revision of the Tertiary formations of the Burma oilfields region was published by Mr. Vredenburg last year (Records Geol. Surv. Ind., vol. li., Part 3). This has been followed by a series of papers issued in anticipation of complete monographs on the Tertiary molluscan fauna, which will be considerably delayed for the reproduction of the required illustrations. The papers issued so far cover the four gastropod families of Terebridæ (vol. li., Part 4), Pleurotomidæ, Conidæ, and Cancellariidæ (vol. liii., Part 2). The completion of this work, if not unduly delayed, should be of great value to oil geologists in their attempts in Burma to identify in newly explored areas the known horizons of the established oilfields.

CHANGES OF CLIMATE IN AUSTRALASIA.—Mr. R. Speight, as secretary of the Cainozoic Climate Committee, has drawn up a valuable report for the Australasian Association for the Advancement of Science (A. J. Mullett, Government Printer, Melbourne). Evidence is adduced from the fossil floras from W. Australia to New Zealand to show that a general warm temperature prevailed in mid-Cainozoic times. Extensive estuarine deposits with shells, and the occurrence of Diprotodon, point to a high rainfall in the Upper Pliocene and early Pleistocene epochs, in what are now arid, or almost arid, regions in Australia. Desiccation followed, extending in the south and centre to the present day. Agreement is expressed with Prof. T. G. Taylor's conclusion that "the climatic belts are moving poleward from the equator. The desert region is encroaching on the southern coasts of the Continent. The northern littoral is getting wetter." The laterites of the northern territory and of northern Queensland are referred to greater aridity here in early Pleistocene times. The cooling that gave rise to a glacial stage, at any rate in New Zealand, may have been as much as 5° C. (9° F.) in southern Australia, and occurred before the aridity set in. The question of a general southern glaciation is, however, not touched on in the report.

NEW SENSITISER FOR GREEN LIGHT.—Dr. W. H. Mills and Sir William Pope of Cambridge (Journal of the Chemical Society, May, p. 946) have discovered a new sensitiser for photographic plates, which they state to be the most powerful sensitiser for green light yet known. It is especially noteworthy also because the gap in the bluish green, which appears almost always when using sensitisers for this region of the spectrum, does not occur with it. The substance, 2-*p*-dimethylaminostyrylpyridine methiodide, is produced as bright red prisms when condensation is caused to take place between *p*-dimethylaminobenzaldehyde and 2-methylpyridine methiodide with the aid of piperidine. Gelatino-bromide plates, after bathing in an aqueous solution containing one part of the dyestuff in thirty or forty thousand parts, show almost uniform sensitiveness to light of all wave-lengths from the blue to about λ 5600, at which point the sensitiveness rapidly declines and ends at about λ 6200.

Carnegie Institution of Washington.[1]

THE year 1921 marks the completion of the twentieth year of organised research conducted by the Carnegie Institution. The original aim of the Founder was to give encouragement and support to investigations or to constructive thought in any department of science, literature, or art, and it is gratifying to record the fact that at the end of this second decade, the function of research as an activity indispensable to civilisation and as a necessary prerequisite of progress, seems to have come into fuller recognition than at any previous time in history. Industrial and government agencies, as well as academic interests, have given to fundamental investigation a high place in the list of elements essential for advance. To-day one may say with confidence that no investment of funds or of personal effort can find a work of greater dignity and worth, or one which offers a future giving clearer evidence of abundant and continuing reward, than is open in the field of research.

The work of the Institution touches in one way or another upon nearly all of the principal fields of research, and the investigations have been very fruitful. They have been not merely contributions to knowledge, but they are also the basis for much research of application which goes immediately into human use. It is not necessary in a preliminary statement to do more than direct attention to some of the most significant results which have signalised certain phases of the work of the Institution in the past year.

It is doubtful whether any recent discovery in the physical sciences has attracted wider interest or has contributed more to the ultimate possibilities of astronomical and physical science than the measurement of diameter of a fixed star carried out at Mount Wilson Observatory three days after the annual meeting of the Institution last year. This long-desired result was made possible by many years of development of plant and technique, together with the extraordinary skill of Dr. A. A. Michelson and his associates and the clear vision of Dr. G. E. Hale in bringing together all of the elements required for this particular task. Measurement of the diameter of the star Betelgeuse once accomplished, the dimensions of other stars followed quickly. More recently, by a refinement of the original method, Dr. Michelson has opened the way for corresponding observations on a group of stars which seemed to be entirely out of range in the first use of the interferometer on the 100-inch telescope. The results already achieved give confirmation of much important work done by other astronomers and furnish a new starting-point for a great variety of investigations concerning the nature of the universe. In consideration of the critical problems involved, provision has been made for securing assistance and co-operation of other investigators, and Dr. H. N. Russell, of Princeton University, who has added much to our knowledge of the evolution of the stars, is now associated with Dr. Michelson and others in helping to solve the special problems to which Mount Wilson Observatory has given attention.

A significant event in the operations of the Institution is the completion within this year of a survey of the seas of the world by the non-magnetic ship *Carnegie*. Launched in 1909, this unique vessel has voyaged nearly 300,000 miles, covering the principal areas of the great oceans and securing data on magnetic conditions previously unavailable, which, with those obtained by concurrent studies on land, give a map of magnetic variations not hitherto possible. With the completion of the year's cruise by the *Carnegie*, and the summing up of its results, attention may be directed more particularly to land observations, to critical studies of terrestrial and atmospheric electricity, to experimental studies bearing upon the nature of magnetism, and to the assembly and interpretation of the great mass of data made available from all sources through many years of field work.

Beginning with the year 1921, the Department of Experimental Evolution and the Eugenics Record Office have come to function as an administrative unit known as the Department of Genetics. By this change, the biological studies of inheritance, based upon investigation of many groups of plants and animals, are brought to bear more directly on studies of human genetics conducted through the Eugenics Record Office. Important as knowledge of heredity is in its application to the development of the animals and plants which contribute to our needs, there is no group of questions more significant in the complicated organisation of human society than those concerning the meaning and the possibility of direction or control of inheritance in man. Without full understanding of the biological factors concerned, it might appear that intelligence and social organisation have brought relatively large opportunity for degeneration. On the other hand, adequate understanding of the principles governing the course of descent may give to mankind opportunity for more rapid and more advantageous development than has been known in the past lines of evolution of other organisms.

During the past year a modest chemical laboratory has been erected for the Department of Botanical Research at Carmel, California. This department has carried its work farther into the field of physical and chemical research in the effort to secure more information concerning the basis of plant activities. The new laboratory offers improved opportunity for fundamental work on photo-synthesis or the chemistry of compounds arising under the influence of light, and it is hoped that with present facilities a nearer approach to the solution of this difficult but fundamental problem in the physiology of plants may be obtained.

An important project in the purely humanistic field is that concerning the ancient Maya civilisation of Central America. The expedition of 1921, led into this region by Dr. S. G. Morley, has secured most significant new material by the study of the ancient monuments and the excavation of building sites. The story of this people contributes much that may become critical or determinative in the interpretation of early American history; the great bulk of this record still remains unread. In the past year the Institution has had the benefit of effective co-operation in this work by Mr. William Gates, whose study of both the modern and the ancient Maya language involves lines of investigation which should relate themselves closely to the archæological studies.

The more noteworthy of the allotments made by the Executive Committee during the past year were as follows: 14,000*l.* for the Department of Botanical Research, 25,000*l.* for the Department of Genetics, 28,000*l.* for the Geophysical Laboratory, 42,000*l.* for the Mount Wilson Observatory, and 46,000*l.* for the Department of Terrestrial Magnetism.

In addition, there were minor grants aggregating 30,000*l.*, and 20,000*l.* was allotted for the production of publications. The total allocations amounted to more than 250,000*l.*

[1] Extracts from the Report of the President of the Carnegie Institution of Washington, Year-book No. 20, 1921.

Since the foundation of the Institution in 1902 there has been distributed, chiefly by gifts to libraries and to authors, but to a noteworthy extent also by sales, a total of no less than 226,039 volumes of publications of the Institution. During the past year the publication of 23 volumes has been authorised by the Executive Committee at an aggregate estimated cost of 12,000*l.*, and 18 volumes, with an aggregate of 4068 octavo and 1398 quarto pages have been issued. Twenty additional volumes are now in press.

Melanesian Witchcraft.

AT a meeting of the Royal Anthropological Institute on Tuesday, May 23, Dr. B. Malinowski read a paper on Melanesian witchcraft. The natives of the Coral Archipelagoes surrounding New Guinea, where Dr. Malinowski carried out his researches, have no idea of natural death or disease. If undisturbed by sorcery, a man would, they believe, live in perpetual good health to an old age, in fact there is no reason why he should ever die.

When a sorcerer wishes to destroy a man, either as an act of personal hate or professionally for a payment, he first administers a small dose of black magic and produces a slight disorder. A spell in which the victim's name is mentioned is chanted over his house or garden, or into some leaves which are buried near his doorstep. The man sickens and is made more susceptible to further evil magic, which is now made stronger by the application of a more dangerous spell, and the pernicious substance must be administered by mouth or else burnt in the victim's hut. At this stage the patient takes all sorts of precautions; his house is guarded by relatives, his food is under control and, last though not least, he engages the services of another professional man—a sorcerer is always also a healer—who tries to undo by magical means all the evil done by his colleague. The sorcerer is most dreaded at night when he prowls round the victim's house, surrounded by night birds, his assistants, and tries to enter the hut and to burn the deadly substance.

If he succeeds, the patient may die, provided the good magic has not proved more effective than the evil. If he fails, the sorcerer may have recourse to the final rite of pointing the bone. A regular witch's cauldron is prepared and boiled somewhere in the jungle, and into its seething contents the sorcerer chants a most deadly spell, uttering the victim's name. Then he dips into the mess a pointed bone, a stingaree spine, or a short wooden dagger. Afterwards he steals to the village and tries to get sight of the victim without being seen himself. Pointing the dagger towards the man he jerks and twists it in the air, muttering the final incantation. The man to whom this is done will invariably die, unless a more effective magic has been used for his protection.

The sorcerer firmly believes in the powers of his black art. When he undertakes professionally to conduct a case, whether of killing or curing, he will carry out the various rites scrupulously, often risking his life in the attempt to kill by magic, for, if caught *in flagrante delicto*, he would be mercilessly speared.

It has to be realised that sorcery is almost invariably used to avenge some real injury or to punish some one who has broken the tribal law. The victim feels the weight of public opinion against him and this enhances greatly his natural fear of magic. It is important also to realise that black magic is generally used in carrying out the decrees of tribal law and usage, and that it is mainly at the disposal of the chief, the man of rank, and the man of wealth. It thus supplies savage society with the wholesome, though undoubtedly unpleasant element of fear, without which no social stability or order can exist in a primitive community. It is always a conservative force, which ranges itself on the side of existing order, authority, law, and custom. It is most unfortunate, therefore, that whenever European civilisation comes in contact with savages, the first thing done is to destroy, or at least undermine, the power of the black magician. It is one of the many cases where a mistaken zeal for giving savages that for which they are not yet ripe results in the disruption of their own social order and in paralysing their own powers, without the substitution of any effective means of control.

The late Dr. Rivers, in opening the discussion which followed the reading of the paper, referred to the value of Dr. Malinowski's investigations in indicating in particular the place taken by sorcery in the social complex as a whole. When examined in this relation, the resemblance which the sorcery of the Trobriands offers to the sorcery of other peoples as, for example, in the Western Solomon Islands, is merely superficial. Sir James Frazer pointed out the parallelism in the development of the arts and of witchcraft in the Trobriands, and indicated further that the theory which underlies this system of sorcery is mechanical in that the spirit acts upon, but did not enter into, the body.

New Buildings of University College, Nottingham.

THE foundation stone of the new buildings of University College, Nottingham, was laid on Wednesday, June 14, by Lord Haldane, in the presence of a large company from all parts of the East Midlands. The site is situated at the highest point of the Highfields estate, being about 2½ miles distant from the centre of the city. The present proposals include the central building, which provides accommodation for the faculties of arts and economics and also for the administrative offices. The library adjoins. There is also provided a block for the departments of chemistry and physics with room for extensions. The departments of biology and geology will be temporarily accommodated in the central building. The departments of engineering, mining, technology, and the evening work of the College will continue to be carried on in the present buildings in Shakespeare Street.

The new buildings at Highfields have been designed on the unit system in such a way that future development of the University is rendered possible. Provision is thus made for the ultimate transference of all departments to the new site. The erection of the new buildings has been made possible by the great generosity of Sir Jesse Boot. About two years ago he gave to the College the sum of 50,000*l.*, of which 20,000*l.* was to be devoted to the endowment of the chair of chemistry and 30,000*l.* to the building fund. He has now added a further sum of 120,000*l.* towards the latter purpose. At the ceremony on June 14, Lord Haldane announced that Sir Jesse Boot had sent a further cheque for 10,000*l.*, and that an anonymous donor had forwarded a cheque for 100,000*l.* in aid of the movement. These two cheques were put by Lord Haldane in the hands of the chairman of the University College. With this

quarter of a million it will be possible to provide the buildings necessary to allow of the removal of the purely academic side of the University College from its present site, and also to provide the administrative accommodation which will be necessary for the proposed University if and when its charter is granted. The University College, by the terms of the draft charter to be presented to the Privy Council, will form the nucleus of the new institution, to be reinforced from time to time by the association of other colleges in the province as they are approved by the Board of Education. Hence it was appropriate for the architect of the new buildings, Mr. Morley Horder, to describe his drawings in the Royal Academy of this year as of the East Midland University.

The buildings will be of sober classical style in the English tradition of Wren. They will be grouped in a range of quadrangles rising from a lake, some twelve acres in extent, with a terraced garden in front. As the railway passenger approaches by the Midland line from Trent, the white Portland elevations of the various buildings will be seen on high ground to the left. Owing to the conformation of the site a view is obtained from the front of the University over the valley of the Trent.

The Highfields Park which surrounds the University buildings affords opportunities for such extensions as the future may demand. Beyond the ample provision thus made, extending to many acres, the large park, by the noble generosity of Sir Jesse Boot, is dedicated to the use of his fellow-citizens. On the southern side of the lake a wide boulevard, containing alternate roads and avenues of trees, affords an approach to the city from the west, and incidentally a means of access to the University buildings. From this boulevard there will open playing-fields, some of which will be allotted to the University. The amenities, therefore, of the city and the University will be combined in a manner which is advantageous to both. The laying out of the boulevard, the lake, and the park will involve a cost of some 200,000*l.*, which again is a gift from Sir Jesse Boot.

The imaginative construction of the whole imposing scheme is peculiarly that of the donor, and his especially is the credit in this respect. There are not many persons who have entered completely into his idea, and it is characteristic of his point of view that he insists that the first part of the buildings to be erected must include the fine terraced garden which shall unite the University buildings with the lake. This garden involves the fine stone retaining walls which are necessary upon the sloping ground. Lord Haldane spoke effectively of the ideal of a civic university, and it thus appears that it will be materialised through a conception which involves, not only the relation of the university to the city, but of the city to the university. Such a conception has formed itself for the first time in the mind of a citizen.

Rothamsted Experimental Station.

The Society for Extending the Rothamsted Experiments on Agricultural Science held its annual meeting at the Rothamsted Experimental Station, Harpenden, on Wednesday, June 14, when some 80 members of the Society and guests were present.

The morning was occupied in the inspection of some of the experimental fields, which were demonstrated by members of the staff. After luncheon the meeting was addressed by Lord Bledisloe, who presided in the absence of the Duke of Devonshire. Lord Bledisloe described the important function fulfilled by the Society for Extending the Rothamsted Experiments in assisting the station to pursue its investigations in agricultural science. He mentioned that it was hoped with the aid of Government grants to begin the construction of new laboratories at Rothamsted for the study of diseases and pests of agricultural crops, and to make other much-needed additions to the station. As the Government grant is conditional upon the station itself raising a certain sum by private donations, the Society hopes to collect 5376*l.* during the current year for this purpose. Lord Bledisloe concluded by voicing the congratulations of the meeting to the director, Sir John Russell, on the honour of knighthood recently conferred upon him in recognition of his work in agricultural science.

Sir John Russell then gave a brief account of the problems under investigation in the laboratories, after which the Minister of Agriculture, Sir A. Griffith-Boscawen, in a short speech, said that the policy of the Government was to make provision for, and to encourage, agricultural education and research as the safest and best means of helping British agriculture. He added that in this policy he had the support of all shades of agricultural opinion, and referred to the general approval of the recent grant of 1,000,000*l.* for education and research which was made when the Corn Production Act was repealed. Sir Daniel Hall, the Chief Scientific Adviser to the Ministry of Agriculture and a former director of Rothamsted, also spoke, and pointed out the great value of the experimental fields to Rothamsted, in that they focussed attention upon problems which had both scientific and practical interest.

Mr. Shepperson of the National Farmers' Union, and Mr. George Dallas of the Workers' Union, also expressed on behalf of their respective organisations their support of the policy outlined by the Minister of Agriculture.

In the afternoon the visitors inspected the laboratories and discussed with the staff some of the investigations in progress. Special attention was given to the work of the entomological and mycological laboratories, which at present is being conducted in unsuitable and overcrowded quarters. It is hoped that the effort of the Society for Extending the Rothamsted Experiments will enable adequate accommodation to be provided for this work in the near future.

University and Educational Intelligence.

Cambridge.—Mr. F. C. Bartlett, St. John's College, has been appointed reader in experimental psychology and director of the Psychological Laboratory. Mr. H. A. Cox has been appointed Gurney University lecturer in forestry. Mr. G. S. Carter, Gonville and Caius College, has been elected to a research studentship at Naples and nominated to use the University table there. Honorary degrees are to be conferred on ex-President Taft, Chief-Justice of the Supreme Court of the United States of America, and upon Mr. H. Stone, University lecturer in forestry.

The following elections and awards are announced: to a Harkness scholarship in geology, H. Hemmings, St. John's College; to Frank Smart prizes in botany and zoology, J. Barker, Trinity College, and C. F. A. Pantin, Christ's College, respectively; to the Wiltshire prize in geology, W. D. West, St. John's College.

St. Andrews.—At a meeting of the University on June 9, a letter was read from Prof. A. S. Butler resigning the chair of natural philosophy as at the end of September. It was agreed to announce the

vacancy of the chair and invite applications. The appointment of a professor of education to the chair vacant owing to the death of Prof. John Edgar has been deferred, and applications are invited for a lectureship in education with a salary of 500*l.* a year. The following appointments have been made: Mr. F. Whyte, to be lecturer in engineering in University College, Dundee; Mr. M. McGibbon, to be demonstrator in botany, and Miss J. M. Reid to be demonstrator in zoology at St. Andrews.

THE United States Bureau of Education has issued as Bulletin No. 30, 1920, a supplement for 1918 and 1919 to the Digest of State laws relating to public education which it published in 1915. It shows considerable activity on the part of the State Legislatures, the output of the two years being about 3000 enactments without counting those of local application or ordinary appropriations. Among those of special interest are the provisions for establishing continuation schools. Seventeen States passed laws making attendance compulsory, in most cases until the age of 18, and for not less than 8 hours a week. Numerous laws were passed to promote "Americanization" through adult education in the English language, civics, etc. Connecticut, for instance, established a State Department of Americanization under a Director; New York required the State University to prepare courses of instruction in patriotism and citizenship and provided for enforcing the attendance of children over 8 years of age; Texas provided for at least ten minutes instruction each day in intelligent patriotism, and required school boards to provide a flag for each school building; S. Dakota required instruction in patriotism in all educational institutions, both public and private. Five States passed acts providing for military training in schools, one (New York) requiring such training not exceeding three hours a week for boys between 16 and 19. Illinois passed a law prohibiting fraternities, sororities, and secret societies in schools.

IN Bulletin No. 8, 1921, of the United States Bureau of Education, Mr. W. J. Osburn of the Department of Education of the State of Wisconsin has brought together a large number of extracts from reports made in the course of the past seventy years by English, French, and German observers. His comments are characterised by the United States Commissioner of Education as fair and helpful interpretation. While the object of the treatise is to extract from the work of the critics its maximum value for Americans, it is of great interest to educationists generally and provides most useful safeguards for those who in other lands are endeavouring to obtain inspiration and guidance from recent developments and experiences in American institutions. Most conspicuous among the criticisms dealt with are, naturally, those contained in the report of the Mosely Education Commission which was sent from England with instructions to find out to what extent American commercial prosperity has been due to their educational system. Many of the criticisms are by French university exchange professors; German critics have, in general, it appears, shown a bias in favour of autocratic methods and a consequent lack of understanding and sympathy. While satisfied that American achievements and tendencies compare, on the whole, favourably with those of other countries, Mr. Osburn directs attention to several serious shortcomings. He says, for instance, that conditions in the teaching profession leave much to be desired as regards salaries, security of tenure, and pensions, although the social standing of the teacher is good, while the annual output of teacher training institutions is less than one-fourth of what it should be.

Calendar of Industrial Pioneers.

June 25, 1879. Sir William Fothergill Cooke died.—While a student of anatomy and physiology at Heidelberg, Cooke in 1836 had his attention directed to the electric telegraph, and in 1837, on his return to England, he became a partner with Wheatstone. Joint patents were taken out in 1837 and 1838 for instruments with five and two needles, and in 1845 the single needle instrument was produced. After that the telegraph was speedily adopted on all the railway lines of the country. The first commercial telegraph of Cooke and Wheatstone was erected in 1837 on the London and North Western Railway between Euston and Chalk Farm.

June 26, 1827. Samuel Crompton died.—Employed in a cotton mill in Bolton, where he was born in 1753, Crompton devoted himself to the improvement of cotton machines. After five years' work, by combining the principle of Arkwright's rollers and Hargreaves' spinning jenny, he was able to produce, by means of his "mule," a yarn of hitherto unexampled fineness. Too poor to obtain a patent he remained comparatively poor, but in 1812 the merits of his invention were recognised by Parliament granting him a sum of 5000*l.*

June 26, 1810. Joseph Michel Montgolfier died.—The elder of the brothers, to whom is due the invention of the hot-air balloon, Montgolfier was born at Annonay in 1740, and became, like his father, a paper manufacturer. His first experiments with balloons were made at Avignon in 1782, and on June 5, 1783, Michel Montgolfier and his brother, Étienne, made the first public experiment in Annonay, where a century later a monument was erected to them. The use of hydrogen in balloons was due to the physicist, Charles.

June 28, 1817. George John Singer died.—The inventor of the gold-leaf electrometer, Singer in early life was a maker of artificial flowers. Given to private study he wrote on electricity and electro-chemistry, made improvements in electrical apparatus, and at his premises in Princes Street, Cavendish Square, gave lectures which were attended by Faraday and Francis Ronalds. He died of consumption at the age of 31.

June 28, 1915. Charles Ernest Paolo Della Diana Spagnoletti died.—For thirty-seven years—from 1855 to 1892—Spagnoletti was chief electrician and telegraph engineer to the Great Western Railway, and in 1885 served as President of the Society of Telegraph Engineers, now the Institution of Electrical Engineers. He brought out numerous electrical appliances for signalling, recording, and controlling, and was the inventor of a dynamo.

June 29, 1890. Alexander Parkes died.—Apprenticed to a Birmingham brassfounder, Parkes afterwards worked for Elkington and, during a period of forty-six years, took out some sixty patents relating to electroplating and other processes. He discovered the method of using zinc for the desilverisation of lead, and about 1855 invented the material now known as celluloid.

June 30, 1893. Jean Daniel Colladon died.—Of Huguenot descent, Colladon was born in Geneva on December 15, 1802. With the mathematician, Sturm—with whom he made experiments on the velocity of sound in the waters of Lake Geneva—he went to Paris and studied under Ampère and Fourier. Returning to his native city, he became a professor in the Geneva Academy and engineer to the Geneva Gas Co. He lectured on the steam engine, brought out a dynamometer, experimented on hydraulics, and was a pioneer in the use of compressed air for the transmission of power.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, June 1.—Sir Charles Sherrington, president, in the chair.—T. H. **Morgan**: The mechanism of heredity (Croonian lecture). The changes taking place when the germ-cells ripen are such that, granting the hereditary elements are carried by the chromosomes, the changes can serve as a mechanism, furnishing an explanation of the principles of heredity discovered by Mendel. In the course of the ripening of the germ-cells, irregularities occur at times in the distribution of the chromosomes, which can be followed in successive generations. The departures from the ordinary course of inheritance that are there shown, are found to be *exactly* related to the new distributions of the chromosomes. The facts furnish convincing testimony that the Mendelian characters are carried by the chromosomes. By the aid of the phenomenon known as "crossing-over" it is possible to determine that the hereditary elements lie in a single line in each chromosome. It is even possible to form a rough estimate of the upper limits of size of these elements, although at present such estimates are necessarily very crude, and are interesting only as the first attempt to determine the size of the "gene."

Geological Society, May 24.—Prof. A. C. Seward, president, in the chair.—A. C. **Seward**: Geological notes on western Greenland. Many localities were visited on the northern and north-eastern coasts of Disco Island, on the coast of Nugsuak Peninsula, also Hare Island, Upernivik Island, Ritenbenk, Sarkak, and Jakobshavn. Greenland is nearly 1700 miles long, with an average breadth of about 600 miles; approximately a hundred glaciers from the inland ice reach the sea, the largest of which, Humboldt Glacier, ends in a cliff 60 miles broad. Various forms of icebergs were seen. An account of the characteristic types of vegetation and the physical and geological features of Greenland was followed by a more detailed description of the Cretaceous and Tertiary sedimentary series of Disco Island and the Nugsuak Peninsula, and of the overlying and protecting basalts which in some places rest directly upon the old Archæan land-surface, to the exclusion of the sedimentary series. Most of the sedimentary rocks are freshwater in origin and there is evidence of recent sinking of parts of the western coast.

Linnean Society, June 1.—Dr. A. Smith Woodward, president, in the chair.—A. C. **Seward**: A study in contrasts: The past and present distribution of certain ferns (Hooker lecture). Ferns spread by vegetative means, and the lightness and resistant nature of their spores make them very successful as colonisers and emigrants. When Treub visited Krakatau three years after its violent volcanic eruption, he found eleven species of ferns as pioneers of the new flora. As a class, ferns are cosmopolitan, though certain of them are strictly limited in their range and highly sensitive to the influence of physical or climatic conditions, *e.g.* the Bracken, *Cystopteris fragilis*, and *Polystichum Lonchitis*. The apparent identity of living with dead plants gives reality to Hooker's idea expressed in one of his letters: "Geology gives no evidence of a progression in plants. I do not say that this is a proof of there *never* having been a progression—that is quite a different matter—but the fact that there is less structural difference between the recognisable representatives of Conifers, Cycadeæ, Lycopodiaceæ, etc., and Dicotyledons of the chalk and those of the present day, than between the animals of those periods and their living representatives, appears to me a very remarkable fact." The unfolding of plant-life through successive stages of earth-history shows a series of outbursts of energy; the records of one period tell us nothing, while those of the next reveal a fresh type of vegetation or, it may be, a single genus in possession of widely scattered regions of the world. The beginnings are always hidden from us. Between the Mesozoic and the Palæozoic records there appears to be a wide gulf. The difficulty of making direct contact between the age of pteridosperms and the succeeding age of ferns may be due to the difficulty of determining whether a Palæozoic fern-like frond should be classed as a pteridosperm or a true fern. In the latter part of the Triassic period we seem to pass suddenly to a new phase of plant evolution which may be intimately associated with some far-reaching event in the physical history of the earth's crust. Possibly crustal foldings in the latter part of the Palæozoic era, and the prevalence of desert or semi-arid conditions over wide regions during a part of the Triassic period, were vital factors influencing the progress of plant development. The rocks accessible cannot give all the clues sought; parts of old continents remain but others are beyond our reach.

The Optical Society, June 8.—Sir Frank Dyson, president, in the chair.—J. **Guild**: Angle comparators of high precision for the goniometry of prisms. The method of substitution is utilised. Measurements accurate to $1''$-$2''$ can readily be made, and with a more elaborate arrangement an accuracy of about $0 \cdot 1''$ is possible. For the latter, minute variations in the direction of a beam of light emerging from a collimator, caused by placing near the focal plane of the latter a "variable prism" of simple design, are measured.—T. **Smith**: The changes in aberrations when the object and stop are moved. If the aberrations of any centred optical system are known, both for an object which intersects all rays transmitted by the system and for the centre of the effective stop, the position in the image space of the emergent portion of a given incident ray is known, and the aberrations in the image of any other object for any stop position can be expressed in terms of those for the first object. The relations in the second case are expressed in terms of the first when the objects are planes normal to the axis of symmetry.—T. **Smith**: The classification of optical instruments. Five classes are proposed, based upon the separation of the four Gaussian constants into two groups according to their signs. This classification cannot be modified by the addition to the system of inverting prisms and the like, and the properties usually associated with the sign of the lens depend upon its class according to the new system. Each class may have systems of positive or of negative power.—T. **Smith** and L. M. **Gillman**: Note on achromatism with one glass. Systems composed of thin lenses of the same kind of glass, and achromatised by selecting suitable positions for the components, are members of the class (AD) (BC), so that if the object is real the image is virtual. Apochromatic systems constructed from normal achromatic lenses belong to the same class. The aberrations for systems constructed of a single glass, but belonging to other classes, are of considerable magnitude.—H. S. **Ryland**: An improved subjective test for astigmatism. The test apparatus consists of an opaque disc perforated along two diameters at right angles with a series of square apertures. These apertures and the distances between them subtend angles of $1'$ at the usual testing distance. The plate is illuminated by diffused light from the rear.

DUBLIN.

Royal Dublin Society, May 23.—Dr. F. E. Hackett in the chair.—H. A. **Lafferty**, and G. H. **Pethybridge**: On a Phytophthora parasitic on apples which has both amphigynous and paragynous antheridia; and on allied species which show the same phenomenon. The Phytophthora in question is *P. Syringæ* (Klebahn) and not *P. Cactorum* (Schroet), which has several times been found causing decay of apples both in Europe and America. In addition to these two species *P. Fagi* also produces two kinds of antheridia. The grouping of the twenty-two species of Phytophthora is discussed and the elimination of the recently erected genus Nozemia proposed. The economic significance of this form of apple rot is small.—A. G. G. **Leonard** and Miss A. M. **Richardson**: The occurrence of helium and argon in the boiling well at St. Edmundsbury, Lucan, Co. Dublin. The gas from the well consists almost completely of "nitrogen" with small quantities of carbon dioxide. The removal of nitrogen and carbon dioxide leaves a small amount of residual gas consisting of argon and helium. The percentages of argon and helium are 0·95 and 0·074 respectively.—H. H. **Poole**: Some further notes on the distribution of activity in radium therapy. Tables are given showing the approximate distribution of activity for different arrangements of emanation needles, and the skin activities with tubular applicators of various diameters and thicknesses.

PARIS.

Academy of Sciences, May 29.—M. Albin Haller in the chair.—The president announced the death of M. Ernest Solvay, at the age of 84 years.—L. **Maquenne** and E. **Demoussy**: Plant growth in media poor in oxygen. Seeds of radish, pea, wheat, and rape germinated in sterile sand and wholly submerged in running water gave seedlings possessing an assimilation capacity comparable with a normal plant. If a small proportion of carbon dioxide is added, the weight of the dry-plant material is higher than, or at least equal to, the weight of the original seed. The leaves of certain species of plants (sorrel, Aucuba) can retain their vitality in the absence of air for a long period.—M. **Riquier**: The singular integral figures of partial systems of the first order to which the method of integration of Jacobi applies.—E. **Mathias**, C. A. **Crommelin**, and H. Kamerlingh **Onnes**: The heat of vaporisation and the difference $m'-m$ of the specific heats in the saturated state for argon, oxygen, nitrogen, and hydrogen.—M. Henri Lebesgue was elected a member of the Section of Geometry in the place of the late C. Jordan.—F. H. **Murray**: Drawing arcs of circles of large radius.—J. W. **Lindeberg**: The law of Gauss.—P. J. **Myrberg**: Automorph functions of several independent variables.—M. **Ferrier**: The deviations of light rays passing in the neighbourhood of a star. A theoretical study of the deviations caused by the atmosphere of a star. This is superposed on the Einstein effect, and in certain cases might mask the latter. The cases of the Earth and Moon are worked out in detail.—J. **Guillaume**: Observations of the Skjellerup comet, made with the *coudé* equatorial of the Observatory of Lyons. Positions are given for six consecutive days, May 19-24, together with the positions of the comparison stars. The comet is vaguely circular, of about 0·5′ diameter and without marked condensation.—Mlle. O. **Jasse**: Observations of the comet 1922b (Skjellerup), made at the Observatory of Marseilles (Eichens equatorial, 26 cm. aperture). One position is given, for May 24.—A. **Danjon**: A new interference method for measuring the apparent diameter of stars. The Jamin system of thick plates is utilised. If the star has no appreciable apparent diameter it disappears completely when passing over the centre of a dark band, but if there is an appreciable disc the extinction will be incomplete. A formula is given for the maximum and minimum brightness, and the determination of the diameter is reduced to the photometric measurement of the maximum and minimum brightness when the star is observed through the interferometer. Experiments have been carried out on an artificial star, but the successful application of the method will depend on the influence of the movements of the atmosphere.—Gustave **Guillaumin**: The plane lines of slipping of pulverent, coherent, or plastic bodies.—Jean **Lecarme**: Experiments relating to the course of a pendulum and a chronometer, carried out at Chamonix and at the Mont Blanc Observatory, between August 1 and September 10, 1921. The chronometers were checked by the wireless signals from the Eiffel Tower and showed an unexplained loss of 30 seconds per day. The values of g at Paris, Chamonix, and the summit of Mont Blanc were determined by the pendulum and compared with the calculated figures.—S. **Zaremba**: The relativist conception of space.—Louis G. **Stokvis**: The circular diagrams of unbalanced triphase systems and the definition of their degree of lack of balance.—H. **Weiss** and P. **Henry**: The influence of the time factor on the interpenetration of solids by chemical reaction. Experiments were made on two pairs of metals—silver-antimony and copper-antimony. The depth of interpenetration was determined for varying times and temperatures, and the results given graphically.—Joseph **Blondeau**: Study of some dialkyl benzyl cyanides and the corresponding alcohols, amides, amines, and acids.—R. **Locquin** and Sung **Wouseng**: The action of acetylene on the sodium derivatives of ketones and the preparation of the dialkylethinylcarbinols. The sodium derivative of the ketone was prepared by the action of sodium amide on the ketone in ether or benzene. This is then allowed to react with purified acetylene with continual agitation and the product decomposed with ice-water. Starting with the ketone $R.CO.R'$ the alcohol $R.R'.C(OH).C{\equiv}CH$ is obtained. The generality of the method is shown by its application to four ketones.—L. **Blaringhem**: Sex heredity in *Lychnis vespertina*.—A. **Lécaillon**: The fecundity of hybrids obtained by crossing the male *Dafila acuta* with the female *Anas boschas*. These hybrids form an exception to the general rule and are fertile.—W. R. **Thompson**: Mathematical study of the action of insect-destroying parasites. Duration of the parasitic cycle and the increase of the proportion of parasite hosts.—Emile F. **Terroine** and René **Wurmser**: The energy yield in the growth of *Aspergillus Niger*. This mould growing in a glucose medium, after certain corrections are made, accounts for 66-70 per cent. of the energy of the glucose. It is pointed out that Fingerling, Köhler, and Reinhardt have obtained values of the same order in the case of the growth of the pig.—MM. Georges **Bourguignon** and **Conduché**: Experiments on the introduction of the iodine ion by electrolysis in man, and its elimination by the urine.

SYDNEY.

Linnean Society of New South Wales, March 29.—Mr. G. A. Waterhouse, president, in the chair.—G. A. **Waterhouse** (Annual Address): (I.) The need for a zoological survey of Australia. The fauna of Australia is a national asset, although probably the finest collections of the Australian fauna will be found in museums outside Australia. Systematic zoological survey has not been attempted. Im-

mediate steps might be taken by the Commonwealth Government to institute a Federal Museum, in which could be gathered together specimens of Australian animals and accurate information concerning their distribution. Doubtless many private individuals would donate part of their collections to form the nucleus of such a display of the Australian fauna. (II.) Breeding experiments with the Satyrine genus Tisiphone. The genus Tisiphone is confined to the coast and Main Dividing Range of eastern and south-eastern Australia, and the *T. abeona* extends, with six sub-species, from southern Queensland into Victoria, but specimens from a small area round Port Macquarie appeared to be natural hybrids. In October 1920, pupæ and larvæ of *T. morrisi* were obtained from Urunga, at the mouth of the Bellingen River, and reared. Similarly, larvæ of *T. abeona* from near Sydney were reared. Crosses were obtained and the work carried to the third generation. The results afford some proof that *T. joanna* is a natural hybrid. The distribution of Tisiphone may help in elucidating the physiography of eastern Australia in Tertiary time. Possibly before the uplifting movement at the end of the Pliocene the ancestor of Tisiphone was in eastern Australia, and became restricted to the higher elevations where moisture was more abundant. The Cassilis Gap was responsible for discontinuous distribution and development took place independently north and south of this Gap. Later the northern and southern forms were able to reach the coast, and where they met the very complex race *T. joanna* was developed.—W. F. **Blakely**: The Loranthaceæ of Australia. Pt. I. The range and origin of the family were given and the seeds and germination, parasitism, union with the host, adventitious roots, mimicry, dispersal and agents of distribution described.—Vera **Irwin-Smith**: Notes on nematodes of the genus Physaloptera, with special reference to those parasitic in reptiles. Pt. II. A review of the Physaloptera of lizards. The characters useful in the determination of the various species received particular attention.—Marguerite **Henry**: A monograph of the freshwater Entomostraca of New South Wales. Pt. I. Cladocera. Descriptions of fifty species, belonging to seventeen genera, were given; five of the species are new and the presence of others in Australia is recorded for the first time.

April 26.—Mr. G. A. Waterhouse, president, in the chair.—H. J. **Carter**: Australian Coleoptera: Notes and new species. No. ii. A series of Chalcotænia, together with a table of the Australian species, and some Australian species of Stigmodera are described. Eight species of Buprestidæ, eleven species of Tenebrionidæ, and one genus and five species of Cistelidæ are new.—F. **Muir**: A new genus of Australian Cixiidæ (Homoptera). The new genus is allied to Leptoclamys Kirk. Specimens were collected near Sydney. The abnormal development of the front legs indicates that the nymph is probably subterraneous in its habits.—T. Harvey **Johnston** and O. W. **Tiegs**: New gyrodactyloid trematodes from Australian fishes, together with a reclassification of the super-family Gyrodactyloidea. The first species of monogenetic Trematoda belonging to the Gyrodactylidæ from Australasia are described. The hosts comprise seven species of freshwater fish and five species of marine fish. A new super-family and five new sub-families are proposed. In addition to the new Australian genera five others are proposed, mainly for North American species. All the known freshwater species show affinities with Australian marine species, thus emphasising the marine origin of the Australian freshwater fish fauna.

Official Publications Received.

Fifty-third Annual Report of the Trustees of the American Museum of Natural History, for the Year 1921. Pp. 259. (New York.)

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106. Ergebnisse aerologischer Beobachtungen. 9. 1920. Pp. x+176. (Utrecht: Kemink en Zoon.) 3.00 F.

Sitzungsberichte der physikalisch-medizinischen Sozietät in Erlangen. 52 und 53 Band, 1920–1921. Pp. xix+221. (Erlangen: M. Mencke.)

Diary of Societies.

FRIDAY, JUNE 23.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—F. W. Woods: Irrigation Enterprise in India.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—J. W. Fisher: An Experiment on Molecular Gyrostatic Action.—Prof. A. O. Rankine and C. J. Smith: The Viscous Properties and Molecular Dimensions of Silicane.—W. N. Bond: The Pressure-Gradient in Liquids flowing through Cones.—Dr. E. E. Fournier d'Albe: Demonstration of a Mercury-drop Method of producing Visual Effects by Means of Sound.

MONDAY, JUNE 26.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (at Medical Society of London), at 5.—Prof. F. S. Langmead, Dr. W. P. S. Branson, and Dr. James: Discussion on Cardiac Children as a Public Health Problem.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—F. Coleman: Types of Difficult Extraction and their Treatment.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presentation of the Royal Gold Medal.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—R. A. Frazer: The Oxford Expedition to Spitsbergen, 1921.

TUESDAY, JUNE 27.

RESEARCH DEFENCE SOCIETY (Annual General Meeting) (at Medical Society of London), at 3.30.—Sir Walter Fletcher: Medical Research and National Life.

MINERALOGICAL SOCIETY (at Geological Society of London), at 5.30.—Dr. W. F. P. McLintock and S. R. Ennos: The Structure and Composition of the Strathmore Meteorite.—A. Brammall and H. F. Harwood: The Dartmoor Granite (part), its Petrology and Accessory Minerals.—H. F. Collins: Some Crystallised Sulphates from the Province of Huelva, Spain.—Prof. H. Hilton: The Graphical Determination of the Constants of a Shear.—Prof. H. Hilton: A Note on Crystallographic Notation.—A. F. Hallimond: Glauconite from Lewes.—Dr. L. J. Spencer: Ninth List of New Mineral Names.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. A. Mawer: The Study of English Place-names.

INSTITUTION OF CIVIL ENGINEERS, at 8.30.—Annual Conv ersazione.

WEDNESDAY, JUNE 28.

ROYAL SOCIETY OF ARTS (Annual General Meeting), at 4.

ROYAL SOCIETY OF MEDICINE, at 5.—Lt.-Col. H. Watkins-Pitchford: Thanatophidia, or Poisonous Snakes of Africa.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—C. E. Tilley: The Petrology of the Metamorphosed Rocks of Start District (South Devon).—Dr. A. R. Dwerryhouse: The Glaciations of the Counties of Antrim, Down, and Parts of Armagh, Londonderry, Tyrone, Monaghan, and Louth in Ireland.

THURSDAY, JUNE 29.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Sir J. J. Thomson: The Analysis by Positive Rays of the Heavier Constituents of the Atmosphere; of the Gases in a Vessel, in which Radium Chloride had been stored for 14 Years, and of the Gases given off by Deflagrated Metals.—Sir Robert Hadfield, Bart.: The Corrosion of Iron and Steel.—Dr. W. B. Dawson: Harmonic Tidal Constants for Standard Ports of Reference in Canada.—Prof. J. C. McLennan and M. L. Clark: The Excitation of Characteristic X-rays from Light Elements.—J. C. Bramwell: An Abnormal Relationship of the Electrical to the Mechanical Response in the Ventricles.—T. S. P. Strangeways: Observations on the Changes seen in Living Cells during Growth and Division.

FELLOWSHIP OF MEDICINE (at Royal Society of Medicine), at 5.—H. J. Paterson: The Diagnosis of Gastric Disease.

INSTITUTION OF ELECTRICAL ENGINEERS (at the Natural History Museum), at 8.30.—Annual Conversazione.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Sir Thomas Horder: Report on Renal Function Tests.—K. Walker: The Accessory Sexual Glands of the Rhinoceros, the Flying Wombat, the Ornithorhynchus, the Zebra, and the Tapir.

FRIDAY, JUNE 30.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at the Royal Horticultural Society's Gardens, Wisley), leaving London 11.15–11.30 A.M.—Annual Field Meeting.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.

PUBLIC LECTURE.

(*The number in brackets indicates the number of the lecture in the series.*)

TUESDAY, JUNE 27.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: The Idea of Value in the History of Philosophy (2).

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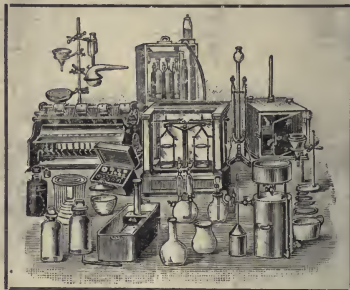

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